THE QUARTERLY REVIEW *of* BIOLOGY

VOLUME 25
1950

Published by
THE WILLIAMS & WILKINS COMPANY
BALTIMORE
U. S. A.

THE QUARTERLY REVIEW OF BIOLOGY

FOUNDED BY RAYMOND PEARL

B. H. WILLIER, *Editor*
The Johns Hopkins University

H. BENTLEY GLASS
Associate Editor

ADVISORY BOARD

IRVING W. BAILEY ..... *Harvard University*
G. W. BEADLE ..... *California Institute of Technology*
E. G. CONKLIN ..... *Princeton University*
ROSS G. HARRISON ..... *Yale University*
LIBBIE H. HYMAN ..... *American Museum of Natural History*
A. L. KROEBER ..... *University of California*
K. S. LASHLEY ..... *Harvard University*
CHARLES W. METZ ..... *University of Pennsylvania*
THOMAS PARK ..... *University of Chicago*
G. H. PARKER ..... *Harvard University*
ALFRED S. ROMER ..... *Harvard University*
ALEX. G. RUTHVEN ..... *University of Michigan*
F. O. SCHMITT ..... *Massachusetts Institute of Technology*
PAUL WEISS ..... *University of Chicago*

CONTENTS

No. 1, March, 1950

The Influence of X-Rays on Limb Regeneration in Urodele Amphibians....*V. V. Brunst* 1
Speciation in Ancient Lakes (Part I).....*John Langdon Brooks* 30
New Biological Books:
Reviews and Brief Notices..... 61

No. 2, June, 1950

Speciation in Ancient Lakes (Concluded).....*John Langdon Brooks* 131
Perspectives in the Field of Morphogenesis.....*Paul Weiss* 177
New Biological Books:
Reviews and Brief Notices..... 199

No. 3, September, 1950

Nutrition and Phylogeny in the Water Molds.....*Edward C. Cantino* 269
Cytochemical Reactions of Nucleic Acids.....*Ethel Sue Lumb* 278
Development and Medusa-Bud Formation in the Hydromedusae.....*N. J. Berrill* 292
New Biological Books:
Reviews and Brief Notices..... 317

No. 4, December, 1950

A Critique on the Phase Theory of Locusts.....*K. H. L. Key* 363
New Biological Books:
The Science of Ecology Today.....*Th. Dobzhansky* 408
Reviews and Brief Notices..... 409

Index..... 425

234761

VOL. 25, NO. 1 March, 1950

THE QUARTERLY REVIEW of BIOLOGY

INFLUENCE OF X-RAYS ON LIMB REGENERATION IN URODELE AMPHIBIANS

By V. V. BRUNST

University of Maryland School of Medicine

INTRODUCTION

AFTER Roentgen's discovery of x-rays, many papers were published dealing with their influence on the process of regeneration in different animals. Regeneration is a process of restoration of a missing organ or part. X-rays have proved to be a powerful and convenient method for experimental studies on regeneration as well as on other biological processes. It is possible that the general biological effect of x-rays on the living organism is based on the effect of x-rays on the mechanism of cell multiplication. Therefore, the investigation of the influence of x-rays on regeneration, in which a very intensive mitotic activity is observed, is particularly interesting. Such studies can give the investigator insight into the nature of the effect of x-rays, as well as knowledge of the nature of the regenerative process, and may enable him to solve certain problems, such as the source of cells for the regenerative blastema.

A knowledge of the nature of the effects of x-rays on the living organism is clearly important not only for experimental biology, but also for medicine. The therapeutic use of x-rays for different neoplastic growths needs a firm theoretical basis instead of a purely empirical one. X-ray biology must provide this theoretical foundation of x-ray therapy.

The most convenient vertebrates for studies on the effects of x-rays on regeneration are the amphibians, inasmuch as these animals possess the greatest ability among vertebrates to regenerate lost organs. Many papers have appeared in this field since the publication of the excellent review by Curtis (1936).

The purpose of the present review is to survey the basic problems in this field, as enumerated below:

I. The mode of action of x-rays in inhibiting regeneration.

II. The source of cells for the regenerating blastema.

III. The influence of x-rays on growth and differentiation in the regenerative process.

In this review some new papers, particularly those in Russian, which have seldom been referred to in the English literature of the subject, will be considered in relatively greater detail than better known publications.

THE NORMAL PROCESS OF REGENERATION

Among the *Amphibia*, the *Urodela* (newts, axolotls, salamanders, etc.) are able to restore limbs, tail, and even parts of the head following injury or amputation. For a short time after the amputation of one of these parts, bleeding is to be observed. However, due to contraction of muscles

and constriction of blood vessels, the bleeding soon stops. Then the healing process begins. The initial epidermal healing of the wound is accomplished by a migration of epidermal cells or by migration of the epidermal layer from adjacent regions. This process occurs without extensive mitotic activity (Korschelt, 1927). The process of wound healing is a separate process which has nothing to do with regenerative ability. It occurs in animals which are able to regenerate missing parts as well as in those animals which are unable to do so. But in animals which possess the ability to regenerate, the latter can be manifested only after the completion of wound healing.

Commencement of the regeneration process depends not only upon the ability of the organ to regenerate, but also upon the presence of suitable conditions. Regeneration cannot begin, for example, in the absence of a freshly healed wound. If, immediately after the amputation of an organ, the wound is closed with adjacent old skin, regeneration does not occur (Godlewski, 1928, and others). It is possible that the skin may be responsible for the suppression of limb regeneration in animals which do not regenerate limbs naturally, such as adult frogs (Rose, 1944). Larval skin is able to promote limb regeneration in the frog (Gidge and Rose, 1944).

The process of regeneration in the Amphibia starts with degeneration (resorption) of the old cut tissues. The giant wandering cells phagocytize all distal portions of the tissues, all cut and damaged cells, dead blood cells, et cetera. Immediately thereafter, in the distal portion of the amputated organ, accumulated mesenchymal cells begin to divide rapidly. These form the rudiment of the new regeneration tissue—the regeneration blastema (Korschelt, 1927). After the formation of the regeneration blastema, a period of more rapid regeneration, with progressing tissue differentiation, is to be observed. By the end of 25 days after limb amputation, three digits appear on the regenerating limb of *Amblystoma punctatum* (Butler, 1933, 1935). Usually within two months after the amputation, the formation of a full-sized limb with 5 digits can be observed in adult tritons (*Triton cristatus*) and in adult axolotls (*Siredon mexicanum*) (Brunst, 1938). The regeneration is a very rapid morphogenetic process. The missing organ may be restored in one-fourth or one-fifth of the time required for normal ontogenetic development.

SOME GENERALIZATIONS CONCERNING THE SPECIFIC INFLUENCE OF X-RAYS ON THE LIVING ORGANISM

Usually the reaction of organisms to x-ray treatment is observed only after a more or less prolonged time. This interval between irradiation and the appearance of the reaction of the organism to the treatment is termed the latent period. Its duration is influenced by many factors. One of these is the rate of division of the irradiated cells (Packard, 1931). The division rates of spermatogonia are high, and they begin to degenerate two hours after irradiation. Lymphocytes, especially in their early developmental stages, are likewise very sensitive. A few hours after irradiation, an "explosive" disintegration of these cells can be observed (Heineke, 1914; Schrek, 1945). According to Spear (1946), "less than 10 r of x-radiation is required to affect the leucocytes of the blood, while a dose of 100,000 r has no demonstrated effect on the isolated frog's heart." Injuries of the skin in man become apparent only after several days (Packard, 1931). Another factor which influences the duration of the latent period is the intensity of the treatment. The greater the intensity, the sooner the reaction appears (Packard, 1931). But according to Schechtmann and Klüpfel (1932), the reaction following treatment of early developmental stages of frog's eggs with a small dose of 20 r units, as well as treatment with a large dose of 72,000 r units, becomes visible after a latent period of at least 24 hours. However, according to Glocker and Langendorff (1933), when a massive dose is administered to the same material in a very short time (for example, 600,000 r in 10 minutes), the latent period is absent, and the reaction takes place immediately in all treated eggs which do not continue cleavage.

Some authors have attempted to explain the presence and variability of the latent period. For example, according to Schwarz (1926), x-rays provoke in treated cells the formation of new chemical substances, actinoproteins, which have weak toxic activity. Gradually these substances transform themselves into more active actinoproteins with greater toxicity. At that time when the quantity of such toxic substances is sufficient to produce some visible changes, the latent period ends, and the reaction of the treated tissues begins. The greater the amount of treatment, the more intense are these changes, and the shorter the latent period. Similar latent periods are ob-

served in reactions of the organism to injections of tuberculin or mustard-oil (Schwarz, 1926). A latent period is observed also after irradiation of amphibian regenerates (Butler, 1933; Brunst and Scheremetieva, 1933; Puckett, 1936; Brunst, 1938). The duration of the latent period in the adult *Triton cristatus* varies from 15 to 30 days (Brunst, 1938).

At the end of the latent period, relatively acute and profound changes in the treated tissues can be observed. These alterations of the cells often cause a suppression of mitotic divisions and signs of pathological degeneration, such as the formation of degenerated giant nuclei or pycnotic nuclei in many cells (visible injuries). All cells with high sensitivity to x-rays die. At this point, in many cases, the reaction of irradiated tissues is similar to an inflammation. This reaction can be termed the "primary acute" reaction (Brunst, 1944). In many cases the injuries to cells can be observed soon after irradiation (Alberti and Politzer, 1924; Canti and Donaldson, 1926; Cox, 1931; Fuchs and Politzer, 1932; Marquardt, 1938; Doljanski and Goldhaber, 1943; and others). After small doses, just sufficient to give the primary reaction, it appears in a mild form only. Thus, irradiation of tissue cultures produces at first a suppression of mitoses, then a stimulation, and finally a return to the normal condition (Canti and Spear, 1928, 1929). A temporary reduction of the division rates in *Paramecium* (Packard, 1931) and a temporary stimulation in eggs of *Planorbis* (Richard, 1914) and *Arbacia* (Packard, 1916) have been observed. If the irradiation is strong enough, the normal mitotic rates are never restored in treated tissue cultures (Canti and Spear, 1929). As stated above, the process of inflammation is a very typical, primary, acute reaction of treated tissues to x-ray injury. The erythema of human skin is a well known example of this. In consequence of the inflammatory process, many of the treated cells and even parts of tissues may disappear. However, in some cases the primary reaction is not observed, in spite of the fact that serious alterations in the treated organ may be detected considerably later. For example, in treated adult limbs of *Triton cristatus* no sign of a primary reaction appears (Brunst, 1944).

Some time after the primary reaction, a stable state in the irradiated organs can be observed to last for an unlimited time. The inflammation and all other phenomena characteristic of the primary reaction disappear before the advent of this stable state. It may arise regardless of whether the primary reaction has been acute, mild, or non-existent. The surviving tissues recover their normal appearance but not certain of their vital potentialities. The cells appear to have lost the capacity to multiply. Since it has not been possible to see such changes with the usual microscopic techniques, they have been designated "invisible injuries." This reaction, or stable state, has been called the "secondary" reaction (Brunst, 1944).

The effect of x-ray irradiation upon the living organism depends not only upon the sensitivity of the tissues of the organism and upon the dose applied, but also upon the method of treatment. Different results may be obtained, for example, by using total or local irradiation, and many other conditions of radiation have also to be taken into consideration. The general effect of a total irradiation of the organism is frequently such a complicated reaction that the simple reactions of separate parts of the organism cannot be distinguished. Moreover, such a complicated generalized reaction often does not allow the treated organism to live on, so as to exhibit the reaction of the organ being studied. Even the size of the locally irradiated area influences the effects obtained. The greater the area treated, the greater the proportion of cells killed (Hercik and Klusakova, 1939).

THE INHIBITION OF REGENERATION BY X-RAYS

A. Total body and local irradiation

A dose of irradiation large enough to provoke a general effect upon the organism also influences the process of regeneration. Scheremetieva and Brunst (1933) have made parallel total body and local irradiation of tadpoles of *Pelobates fuscus* with regenerating tails. The regenerating organs were influenced more strongly by the total body irradiation than by the local, as they were influenced indirectly, through the irradiation of the body, as well as directly. Indirect influence of this sort is suggested by the work of Caspary (1926), who believed that injury and disintegration of cells results in the formation of substances, termed necrohormones, which are carried by the blood stream (cf. Calo, 1932; Barnes and Furth, 1943). Necrohormones evidently may be postulated to explain the reaction of parts of the body not directly exposed to massive treatments (Leblond and Segal, 1942). However, no influence of irradi-

ated media on tissue cultures has been found by Osgood (1942) or others. Experiments have been made in which the entire bodies of axolotls (*Siredon mexicanum*), with the exception of regenerating limb buds which were carefully protected from irradiation, were given a lethal dose. The legs regenerated normally before the animals died (Litschko, 1934). When the posterior halves of the bodies of *Amblystoma punctatum* larvae were irradiated, normal regeneration was observed in amputated forelegs (Butler, 1934). In other experiments, untreated *Amblystoma* legs were transplanted onto a treated host, and after the transplant became established, a part of it was amputated. Regeneration took place normally (Butler, 1935). In all the latter cases, radiation of the body elsewhere failed to influence the local regeneration process.

The total treatment of individuals with a regenerating part has been made by several investigators (Schaper, 1904; Litschko, 1930, 1932, 1934; Butler, 1931, 1932, 1933; Scheremetieva and Brunst, 1933; Crummy, 1935; Puckett, 1936; Butler and Puckett, 1940). No clear picture, however, of the influence of total body irradiation on the regeneration process has emerged. It is particularly unfortunate that the amounts of treatment necessary for the suppression of the regeneration process are lethal to the organism, and therefore prevent long continued observations on this process. For this reason, many authors have applied local irradiation to regenerating body parts (Brunst and Scheremetieva, 1933, 1937a, b; Brunst and Chérémétieva, 1935a, b; Scheremetjewa and Brunst, 1933, 1935, 1937, 1938; Litschko, 1934; Butler, 1935; Umanski, 1937; Brunst, 1937a, 1938a, b, 1941, 1944; Butler and O'Brien, 1942). The localization of the treatments has been attained by various means. In some experiments the animal, except for the part to be treated, was protected by lead rubber (Litschko); in others, lead plates were used to protect the animal (Butler; Butler and O'Brien); yet again, the animal to be treated has been covered by a lead cover with a localizer tube (Brunst and Scheremetjewa; Scheremetjewa and Brunst).

When the leg of an adult *Triton cristatus* is given 10,000 r units of x-rays through a narrow localizing tube, regeneration is completely inhibited in about 95 per cent of the individuals. Administration of 4000 r produces, with a similar technique, a complete inhibition of regeneration in only 54 per cent of the animals, while in the remainder all possible degrees of disturbance may be observed. Extremely variable results are obtained after treatment with 1500 to 2500 r units; all degrees of retardation and inhibition of regeneration are to be observed (Brunst and Scheremetjewa, 1933; Brunst, 1938). Analogous erratic results caused by small doses of x-rays on embryonic developmental processes and on the growth of tumors have been found by Bardeen (1909), Holthusen (1921), and others. Complete uniformity of results, such as the complete supression of the regenerative process, is rather difficult to obtain, a treatment several times greater than that which suffices to induce the effect in 50 per cent of the individuals being needed. Some cells remain uninjured even after heavy irradiation (Crowther, 1924; Dessauer and Caspari, 1926; Dessauer, 1931; Packard, 1931). This is true for total body irradiation as well as for the irradiation of separate organs, eggs, or tissues. This is well illustrated by the results of irradiating *Ascaris* eggs (Holthusen, 1921) and *Drosophila* eggs (Packard, 1931).

A dose of 5000–6000 r units is large enough to suppress regeneration in the adult axolotl, *Siredon mexicanum* (Scheremetjewa and Brunst, 1935; Umansky, 1937). In *Eurycea bislineata*, a dose of 5000 r units inhibits regeneration (Butler and O'Brien, 1942). This does not mean, however, that such an amount of radiation is sufficient to suppress regeneration in any amphibian. The sensitivity to radiation varies not only in widely divergent species but even in closely related forms. For example, 500 r units is absolutely lethal for a guinea pig, while a lethal dose for a mouse is close to 1200 r units (Clark, 1934; Ellinger, 1945; see also Henshaw, 1944). This makes it difficult to derive generalizations from the results obtained with any one animal.

The problem arises as to how to interpret the inhibition of the capacity for regeneration. A priori, it may be considered either temporary or a permanent disappearance of the capacity. This problem can be settled only by observing the behavior of treated animals over long periods of time. One limb of each of several individuals of *Triton cristatus* was subjected to local treatment with variable amounts of x-rays (Brunst and Chérémétieva, 1936). During 5 to 6 years of observation, these limbs were amputated repeatedly, in some animals three, in others four, five, six, or seven times. In 13 cases the regenerative capacity

was found to be completely destroyed, while regeneration of the untreated control limbs on the opposite sides of the same animals took place quite normally. These 13 animals had been irradiated with different doses of x-rays: 3 with 15,000 r; 8 with 3750 r; 2 with only 1500 r. Figure 1 shows the sizes of irradiated and control regenerating limbs during the period of observation. Similar observations were made upon axolotls, *Siredon mexicanum* (Brunst and Chérémétieva, 1936; Scheremetjewa and Brunst, 1937).

Attempts were made by means of traumatization to stimulate irradiated limbs of *Triton cristatus* to regenerate. The distal side of each irradiated stump was pricked and the wound surface scratched by a needle (see Tokin and Gorbunova, 1934). Such traumatization had no effect on regeneration after heavy irradiation (15,000 or 7,000 r). Regeneration did not take place (Brunst, 1938).

B. Effect on the regenerating limb of irradiation after amputation

The problem of the differential sensitivity to radiation of cells at different stages of the mitotic cycle has been considered extensively. Many authors hold that dividing cells are most susceptible. Some of these have regarded the prophase as the most sensitive stage (Packard, 1916; Strangeways and Hopwood, 1926; Henshaw, 1938, 1940; Henshaw and Cohen, 1940; Creighton, 1941; Carlson, 1942); some, the metaphase (Holthusen, 1921; Whiting, 1940; Bozeman, 1943); some, the anaphase (Creighton, 1941; Sparrow, 1944); and still others, the telophase (Vintemberger, 1928; Luther,

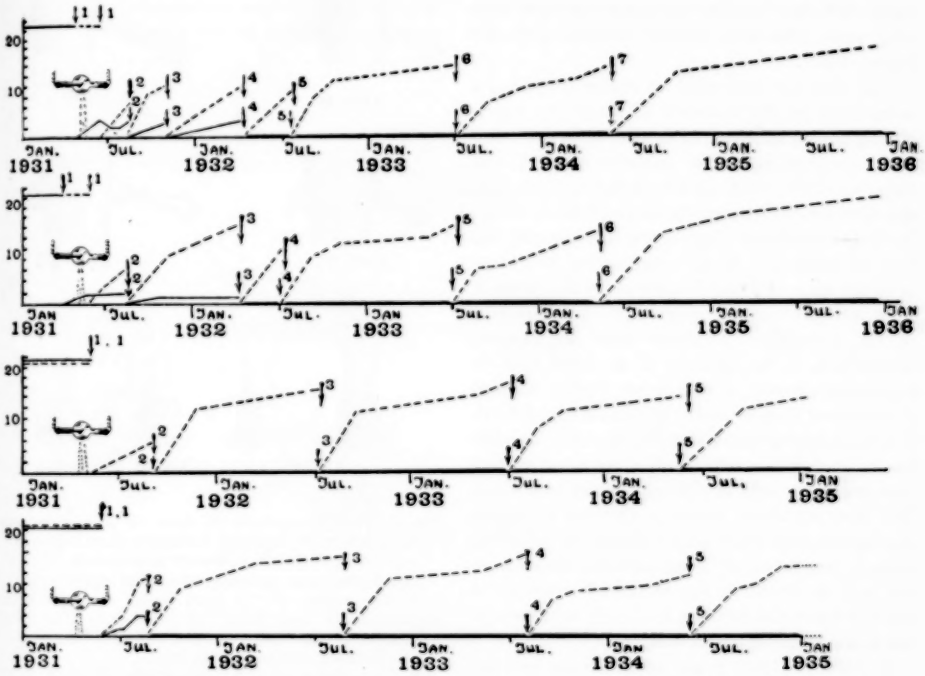


FIG. 1. INHIBITION BY X-RAYS OF THE GROWTH OF REGENERATING LIMBS IN TRITON CRISTATUS

Growth curves of limb regenerates during several years. Ordinates: sizes of limbs and regenerates in mm. Abscissas: periods of observation. The x-ray tubes symbolize the time of irradiation of the right limbs. The growth curves of the irradiated limbs are shown by continuous lines, those of the control (left) limbs by dotted lines. The arrows show the times of amputations. The number beside each arrow gives the ordinal number of the respective amputation. In all cases, irradiation with 3750 r. (After V. V. Brunst and E. A. Chérémétiéva, 1937).

1938). "Practically every stage of the cycle (mitotic) has been regarded as the most sensitive phase" (Giese, 1947, p. 267). Some investigators have not found the dividing cells particularly sensitive (Love, 1934). Possibly Politzer (1930) is nearest the truth in thinking that the fact that abnormal mitoses are observed after irradiation does not necessarily mean that the dividing cells are most sensitive. The resting cells also are injured, but their injuries are made manifest only after such cells have entered division (see also Butler, 1932).

This view was confirmed by studies involving a comparison of the influence of x-rays on regenerating and on adult amphibian limbs. Such studies were made with *Triton cristatus* (Brunst and Scheremetjewa, 1933) and with the axolotl, *Siredon mexicanum* (Scheremetjewa and Brunst, 1935). In these experiments the regenerates were, at the time of treatment, in the regenerating bud stage or in the stage of finger formation. In the group of adult animals used for comparison, the irradiation of the extremities preceded their amputation. Suppression of the capacity of an adult limb to regenerate proved to require no greater amount of treatment than is needed to suppress the growth of a regenerating extremity. Yet an adult limb has few or no dividing cells, while a regeneration bud contains many cells in different stages of mitosis. This does not mean, however, that the adult and the regenerating limbs react similarly to radiation. Indeed, irradiation of a regenerating limb causes not only an arrest of regeneration but usually a more or less rapid decrease in size, or reduction, of the treated regenerate, as well.

If 5,000 to 7,000 r are administered to two-months-old limb regenerates in axolotls, such a reduction is observed in nearly every animal (Brunst, 1938, 1941, 1944). Following irradiation, regeneration continues normally for 2 to 6 weeks, sometimes even up to several months. After this latent period, regeneration stops and reduction begins.

The reduction always begins in the distal end of the regenerate. Thus, if at the onset of reduction the bud has rudiments of toes, the distal ends of the toes are first to show reduction in size. One of the signs of the beginning of intensive reduction is a change in coloration of the regenerating limb. The toes and adjacent portions lose their pigmentation and become light and semi-translucent. This is caused by a change in the pigment layer (Brunst, 1941, 1944), a characteristic biological reaction which has been described by numerous authors (Levine, 1931; Smith, 1932; Scheremetjewa and Brunst, 1933; Ellinger, 1940; Davison and Ellinger, 1942). The pigmentation is usually destroyed; but occasionally, on the contrary, it is intensified, an effect explainable by the redistribution of pigment cells in the skin. The epidermis of the regenerating,

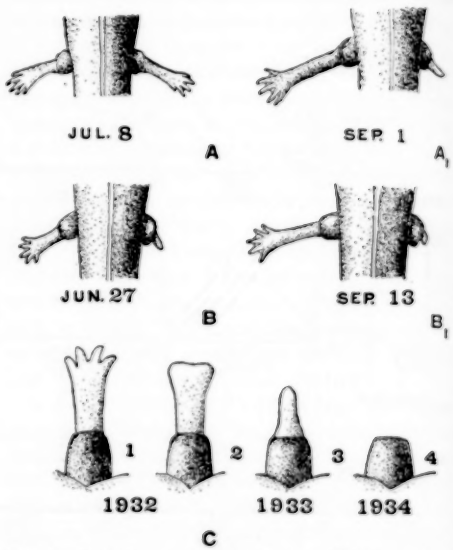


FIG. 2. THE REDUCTION IN SIZE OF X-RAYED AND THE GROWTH OF CONTROL REGENERATING LIMBS IN THE AXOLOTL, SIREDON MEXICANUM

(Semi-schematic drawing of actual specimens).

A. The region of the hind limbs, 60 days after amputation of both limbs and three days after local irradiation of the right regenerate with 6000 r.

A_1. The same region 54 days later.

B. The region of the hind limbs, 41 days after amputation of both limbs and 32 days after local irradiation of the right stump and small regenerate with 3750 r.

B_1. The same region 78 days later.

C. 1. The hind limb 41 days after local irradiation of its regenerate with 15,000 r; 2. The same extremity 18 days later; 3. The same extremity one year later; 4. The same extremity one year and 5 months later. (After V. V. Brunst, 1938).

and now reduced, limb remains intact, and no open wound is formed. If the process of reduction continues unabated, then, following the disappearance of the toes, it continues proximally until complete dissolution of the regenerate has taken place.

The reduction process, however, varies in intensity. In some cases the regenerating limb becomes completely destroyed in a few months

(Fig. 2A, B). In other cases, a slow but steady reduction process goes on for several years (Fig. 2C). In the case illustrated the process continued for at least 2 years and 5 months, resulting in complete destruction of a well developed regeneration bud with rudiments of toes (Brunst, 1938, 1944).

Histological examination of the limbs undergoing reduction has shown that their structure differs widely from that of normally regenerating limbs, as well as from normal adult limbs. Limbs 0.1–0.12 mm. in length (Fig. 3, A–F), equalling the entire thickness of the normal epithelial layer. The giant cells are amoeboid and devoid of any fixed shape. Each possesses a large granular nucleus and a nucleolus (Fig. 3C). The nucleus may be obscured by the presence of various inclusions in the cytoplasm (Fig. 3D, E). Mitotic divisions of the giant cells have been observed (Fig. 3H). Phagocytic activity of these giant cells has been established by direct histological observation (Fig. 3F). The reduction process is clearly connected

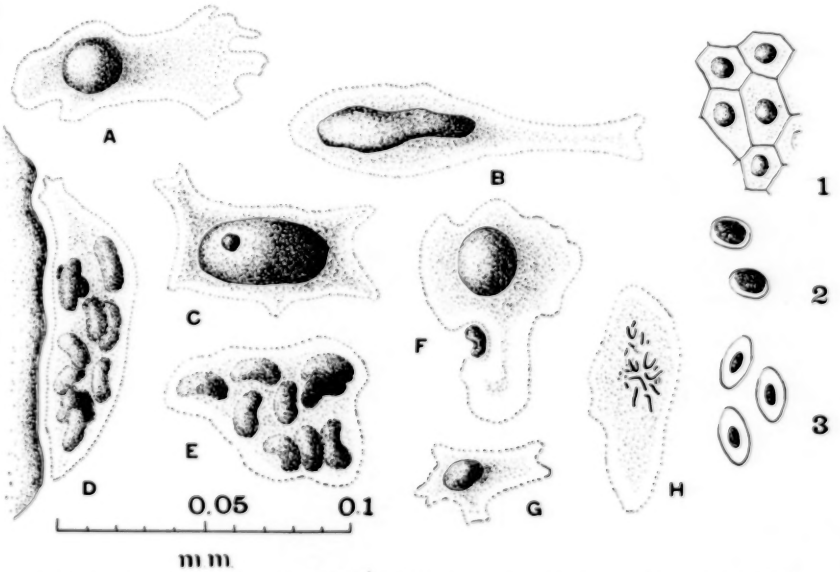


FIG. 3. CELLS OF NORMAL AND X-RAYED TISSUES IN THE AXOLOTL, SIREDON MEXICANUM (Drawn at the same magnification with the aid of a camera lucida).
1–3: Normal cells of an untreated axolotl. 1, epithelial cells; 2, connective tissue cells; 3, erythrocytes. A–H: Giant cells of the regenerating limbs after treatment with various doses. (After V. V. Brunst, 1944).

undergoing reduction contain large numbers of cells which are strikingly different from the normal tissue constituents, and are characterized by their large size, the smallest being two to three times as large as connective tissue cells. These "giant" cells of various shapes and sizes are shown semi-schematically in the figure (Fig. 3). Normal epithelial cells, connective tissue cells, erythrocytes, and a micrometer scale are given for comparison. The length of an erythrocyte is about 0.02 mm. and the normal epithelial cells about 0.02–0.03 mm. The connective tissue cells are even smaller. A majority of the giant cells are 0.04 to 0.06 mm. long (Fig. 3G). The largest ones measure up to

with the presence of these giant cells and with their destructive activity. The portions of the limb in which this process is going on can be definitely identified by their presence. Parallel with the accumulation of the giant cells, the irradiated tissues and tissue complexes disappear in the limbs undergoing reduction.

The reduction of different tissues occurs as follows (Brunst, 1941, 1944). The continuous subepithelial pigment layer is absent in the semi-transparent regenerating limbs undergoing reduction. Giant cells are found in the tissue underlying the disappearing pigment layer. Usually one can see scattered single pigment cells, and in some

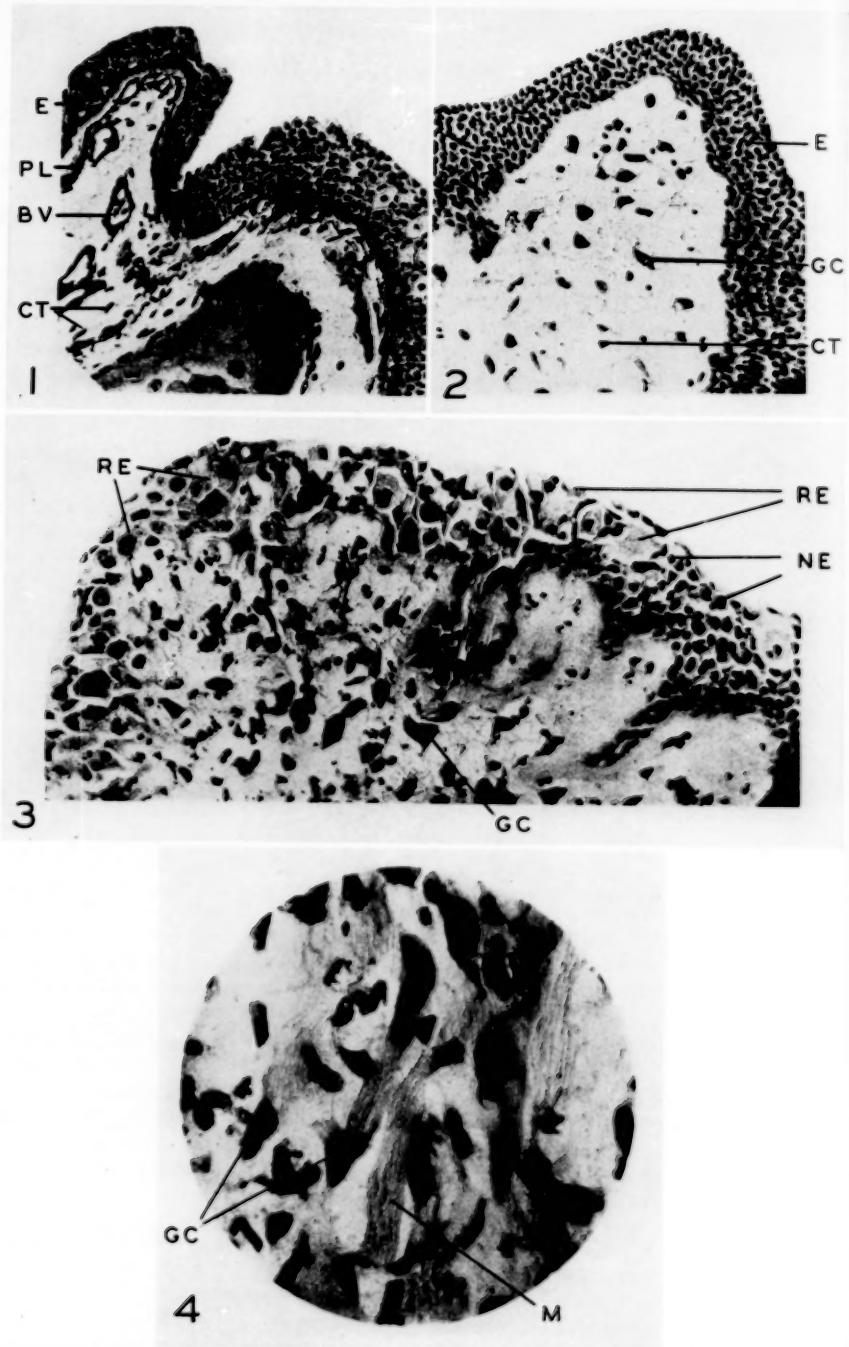


FIG. 4. REDUCTION OF X-RAYED REGENERATING LIMBS IN THE AXOLOTL, SIREDON MEXICANUM

1. Part of a section through a regenerating limb of a control animal, showing the normal subepithelial pigment layer. E, epithelium; PL, pigment layer; BV, blood vessel; CT, connective tissue cells. × 120.

2. Part of a section through a regenerating limb x-rayed with 6000 r and undergoing reduction. GC, giant cell; other symbols as above. Note that all pigment cells have disappeared. × 120.

3. Part of a section through a regenerating limb x-rayed with 7000 r. Reduction of the epithelium. RE, epithelium in process of reduction; NE, normal epithelium; GC, giant cell. × 200.

4. Part of a section through a regenerating limb x-rayed with 7000 r. Reduction of the muscles. GC, giant cells; M, muscle fiber. × 450. (After V.V. Brunst, 1938, 1944).

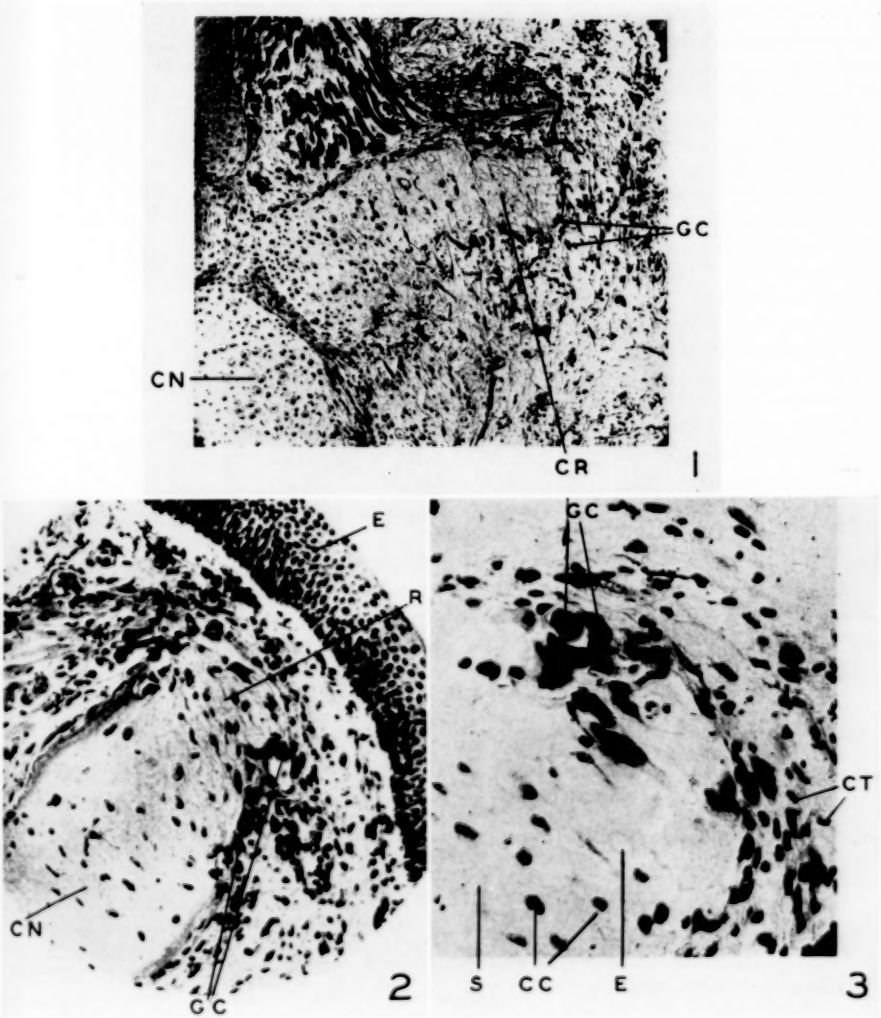


FIG. 5. REDUCTION OF X-RAYED REGENERATING LIMBS IN THE AXOLOTL, SIREDON MEXICANUM

1. Part of a section through a regenerating limb x-rayed with 7000 r, undergoing reduction. CN, normal cartilage; CR, cartilage in process of reduction; GC, giant cells. × 50.
2. Part of a section through a regenerating limb x-rayed with 6000 r. Reduction of the distal part of the toes. E, epithelium; CN, normal cartilage; R, cartilage in process of reduction; GC, giant cells. × 100.
3. Part of a section through a regenerating limb x-rayed with 7000 r, showing penetration of the giant cells into the cartilage, which is undergoing reduction. CC, cartilage cells; S, the cartilaginous intercellular substance; E, empty space previously occupied by a cartilage cell; GC, giant cell; CT, connective tissue cells. × 200. (After V.V. Brunst, 1944).

parts even such single cells are lacking (Fig. 4, 1 and 2). Characteristic changes in the epithelium of the toes undergoing reduction can be noted. On the distal ends of the toes it becomes reduced in thickness, sometimes down to two layers of cells, whereas the normal epithelium of a regenerating limb has from 7 to 10 cell layers. Spaces or cracks form between the enlarged epithelial cells, and

large groups of giant cells appear in the subepithelial tissue, although only a few of them lie in immediate proximity to epithelial cells (Fig. 4, 3). This fact suggests that the epithelium is reduced because of lytic enzymes secreted by the giant cells. The epithelial covering gradually recedes and becomes reduced simultaneously with the disintegration of the subepithelial tissues in the region where phagocytosis is occurring. The giant cells concentrate around the muscles of the limbs undergoing reduction. It is probable that musculo-lytic enzymes are also secreted by the giant cells (Fig. 4, 4). The process of reduction of the cartilaginous skeleton is perfectly clear. The distal cartilaginous elements of the reducing limb look distinctly different from the proximal elements (Fig. 5, 1). The number of cartilage cells in the distal elements decreases rapidly; numerous empty cavities are evident in areas once occupied by the living cells. Large numbers of giant cells are massed around the skeletal elements undergoing reduction. At higher magnifications giant cells can be seen attached to the surface of the cartilage, and eventually penetrating the cartilaginous substance (Fig. 5, 2 and 3). Cartilage cells occasionally may be seen engulfed in the cytoplasm of the giant cells (Fig. 3D, E and Fig. 5, 3). Thus the process of reduction of the cartilaginous tissue is accomplished, at least in part, by phagocytosis. This is probably combined with a lysis of the cartilage substance by enzymes secreted by the giant cells. The degree of disintegration of the skeleton of the limbs in the process of reduction can be judged from the reconstructions shown in Figs. 6 and 7.

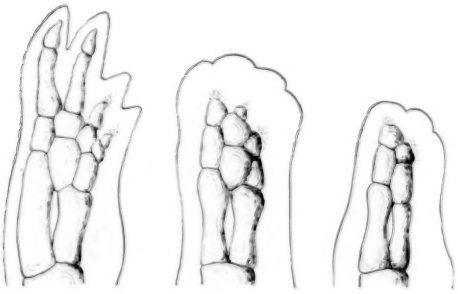


FIG. 6. REDUCTION OF REGENERATING LIMBS X-RAYED WITH 6000 R IN THE AXOLOTL SIREDON MEXICANUM

Reconstructions of skeletons. A, B, C, differing degrees of reduction in different individuals. Aggregations of giant cells are indicated by stippling. (After V. V. Brunst, 1944).

It is instructive to compare the process of reduction observed in the irradiated regenerating limbs with resorption such as takes place in the normal development of certain amphibians, especially that which occurs at the time of metamorphosis of anuran tadpoles. Studies on the resorption of the tadpole's tail have shown that this process occurs by means of phagocytosis and histolysis (Batallion, 1891; Duesberg, 1906–1907; Aleshin, 1936; and others). It too begins distally and progresses proximally. Large aggregations of macrophages (giant cells) were found by Aleshin (1936) in the distal end of the tail of each metamorphosing tadpole. A majority of these macrophages are derived from the blood cells, and only a few are mesenchymal in origin. Resorption of the tadpole tail is a reaction not unlike that involved in inflammation. Indeed, the resorption of the tail begins and progresses like a typical inflammation, although the end result of the process is quite different, inflammation resulting in the ap-

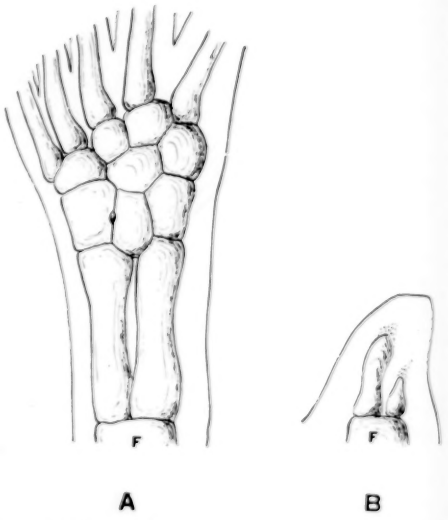


FIG. 7. NORMAL REGENERATION OF AN UNTREATED LIMB AND REDUCTION OF AN X-RAYED REGENERATING LIMB IN THE AXOLOTL SIREDON MEXICANUM

Reconstructions of skeletons of the same age of (A) a control regenerating limb, and (B) of a limb x-rayed with 7000 r, in the same animal. F, femur. (After V. V. Brunst, 1944).

pearance of a connective tissue scar, whereas resorption leads to complete disappearance of the tail (Aleshin, 1936). Since the resorption of the tadpole's tail and the reduction of the limbs in x-rayed axolotls are so similar, the latter process also resembles inflammation, even though the final results of reduction and of inflammation are again quite different (Brunst, 1941, 1944).

One might compare the giant cells observed in the reduction process in the axolotl with polyblasts or macrophages in the sense of Mechnikov (see Maximov, 1906a, 1906b, 1923, 1932). These actively wandering connective tissue cells, which generally appear at the sites of inflammatory processes, should be expected in the irradiated body parts, since such a process occurs here. These cells migrate toward inflamed sites from the rest of the body. According to Maximov (1906), polyblasts may arise from fixed macrophages which possess the potentiality of wandering when under the influence of certain stimuli. According to Maximov and Bloom (1942), "when local inflammatory stimuli act upon the fixed macrophages in any type of connective tissue, they are transformed into free inflammatory macrophages or polyblasts." In the irradiated axolotl, the origin of the macrophages from the blood elements appears highly probable, but it would seem unlikely that any of these macrophages could arise from the connective tissue of the x-ray-treated regenerating limb. One possibility that cannot be excluded, however, is that some of them may come from the connective tissue of that part of the regenerating limb which was not directly x-rayed.

Numerous observations show that giant cells (polyblasts or phagocytes) occur in radiated areas of amphibians at the time of the primary acute reaction to irradiation (Brunst, 1944). When the inflammation and other phenomena of the acute reaction to irradiation are over, these cells disappear from the irradiated tissues Phagocytosis following irradiation has been found in insects (Carothers, 1940), amphibians (Litschko, 1935; Brunst, see above), and mammals (Tsuzuki, 1926; Kosaka, 1928). The giant cells described in guinea pigs by Torrioli and Florentino (1935) also may be phagocytes.

Reduction is not a reaction specific to regenerating limbs. The reduction phenomenon has also been observed in locally irradiated developing limbs of the axolotl, *Siredon mexicanum* (Brunst, 1938). The latent period after treatment with 5000 to 7000 r units was found to last for 2 to 4 weeks, during which time the limbs continue their normal development. This was followed by an arrest of the growth of these limbs, after which a typical reduction process ensued in 50 to 60 per cent of the individuals studied. In the axolotl the reduction process in the irradiated developing limbs is not distinguishable from an analogous process in irradiated regenerating extremities. Giant cells (polyblasts or macrophages) also are found in irradiated tissues of young developing organs (developing limbs in *Amblystoma*, Puckett, 1936; developing limbs in the axolotl, Brunst, 1938; growing tails and other parts of young axolotls, Brunst, 1944a).

Butler (1933) has studied the histology of irradiated regeneration buds in larval stages of *Amblystoma punctatum*. After a six-day latent period, a process of gradual dissolution of cartilage begins in the irradiated regenerating limbs. In the control animals, a rapid differentiation of the skeletal elements begins at about the same time that dissolution starts in the irradiated animals. The disintegration of the cartilaginous skeleton proceeds in the proximal direction. The cells composing the core of the regeneration bud disappear, leaving the bud empty. In the opinion of Butler, based on his study of the larvae of *Amblystoma punctatum*, the x-rays effect first of all the differentiation of the regeneration blastema. In the absence of differentiation, which was suppressed by irradiation, the dedifferentiation process destroys the cartilaginous skeleton and other tissues. Puckett (1934, 1936) also observed dedifferentiation of all tissues after irradiation of *Amblystoma* larvae. Butler and Puckett (1940) have claimed that: "Excessive dedifferentiation is not a direct effect of radiation. The hypothesis is proposed that dedifferentiation normally is checked through activity of the blastema. When the blastema is inactivated then dedifferentiation remains unchecked and proceeds to great extremes" (p. 237).

Obviously the process of unlimited dedifferentiation in larval stages of *Amblystoma punctatum* and in tadpoles of *Rana sylvatica* after x-ray treatment (Butler, 1933; Puckett, 1934, 1936, 1937; Butler and Puckett, 1940) and the reduction process following x-ray treatment of regenerating limbs in *Triton cristatus* and the axolotl *Siredon mexicanum*, as well as the reduction of young developing organs in the axolotl, are identical phenomena. Puckett (1936) described "giant" cells

but did not ascribe to them any particular significance. He said: "Cells in mitosis show especial peculiarities; such cells become many times larger than the normal and form what might be termed 'giant cells'. . . ." (p. 187). "Figure 20 shows a few cells remaining, among these a large 'giant cell,' in this case many times larger than the normal mesenchyme cell" (p. 188).

The reduction process may thus be regarded as a primary acute reaction to irradiation of organs that consist of relatively young, undifferentiated, and rapidly dividing cells. Such cells are more sensitive to irradiation than differentiated ones, as Bergonié and Tribondeau pointed out as early as 1906.

It should be noted that in amphibians the process of reduction may be provoked by means other than x-ray treatment. For example, a reduction of regenerating limbs in *Triton* has been observed following destruction of their innervation (Schotté, 1926; Brunst, 1926). Similar results were obtained in larvae of *Amblystoma punctatum*, *Amblystoma opacum*, and *Triturus viridescens* (Butler and Schotté, 1941; Schotté and Butler, 1941).

C. *Effect of irradiation prior to amputation (treatment of the adult extremity)*

According to Schaper (1904) and Puckett (1936), the tissues of an adult organ are less sensitive to irradiation than the tissues of a regenerating structure. As other investigations have shown (Brunst and Scheremetjewa, 1933; Brunst and Chérémétieva, 1935; Scheremetjewa and Brunst, 1935; Brunst, 1938, 1944) adult organs react to irradiation differently from regenerating ones. No reduction is ever observed in irradiated adult organs. But if very large doses are used, necrosis may be observed. A characteristic feature of x-ray induced necrosis is the injury of the integument. Therefore necrosis always begins with the formation of open wounds. The soft tissues of the limb or the tail rapidly disintegrate and fall off piece by piece. Naked skeletal elements fall off gradually. Necrosis may begin in the distal as well as in the proximal part of the organ, and progresses rapidly. The entire distal part eventually falls off. However, after treatment with the same dose of x-radiation, necrosis of adult limbs occurs much less frequently than does the reduction of regenerating limbs.

It is reasonable to suppose that the further the development of a regenerating limb has proceeded, the more its reaction to irradiation will be similar to that of an adult limb. Irradiation of regenerating *Triton cristatus* at different stages, i.e., with different numbers of toes, produced approximately the same results in all stages (Brunst, 1938). It was concluded that the transformation of a regenerating limb into an adult extremity takes place long after the formation of the complete number of toes. Experiments have been performed with *Triton cristatus* in which nine-months-old regenerating and adult limbs were treated with x-rays. The proportion undergoing reduction was much lower than in younger regenerating limbs, being only 25 per cent instead of 95 per cent (Brunst, 1938). Thus, the reaction of a nine-month-old regenerating limb approaches, yet does not quite equal, the reaction of adult limbs.

The amount of radiation which destroys the capacity of an adult limb to regenerate in triton or axolotl usually produces no visible changes in it. In many experiments, stumps of irradiated extremities consisting of adult tissues have persisted for long periods of time without showing any ability to regenerate (Brunst and Scheremetjewa, 1933; Scheremetjewa and Brunst, 1935, 1937; Brunst, 1938). One could infer that a whole limb could still exist although its regenerative capacity had been destroyed. A massive dose of x-rays (15,000 r, 7000 r, or 4000 r) was given to the proximal part of triton limbs. The irradiated limbs retained their normal appearance, movements, and cutaneous sensitivity. No apparent differences between the irradiated and the control limbs of the same animal were perceived. An amputation of both legs, control and treated, was performed two months after irradiation. Despite the similarity in appearance of the limbs before amputation, no regeneration was observed on the irradiated side, while the control limbs regenerated normally (Brunst and Sheremetieva, 1937). These results show that an irradiated organ may remain alive despite loss of its capacity to regenerate.

According to Luther (1939), in irradiated salamander larvae the differentiated skin cells are not injured by x-rays, but all processes of cell division are completely blocked. This author has given much significance to the fact that cells which normally divide every 3 to 4 days may, after irradiation, continue for months without dividing. According to Osgood (1940), the "action of irradiation is to prevent the onset of mitotic or amitotic division and not by directly killing cells."

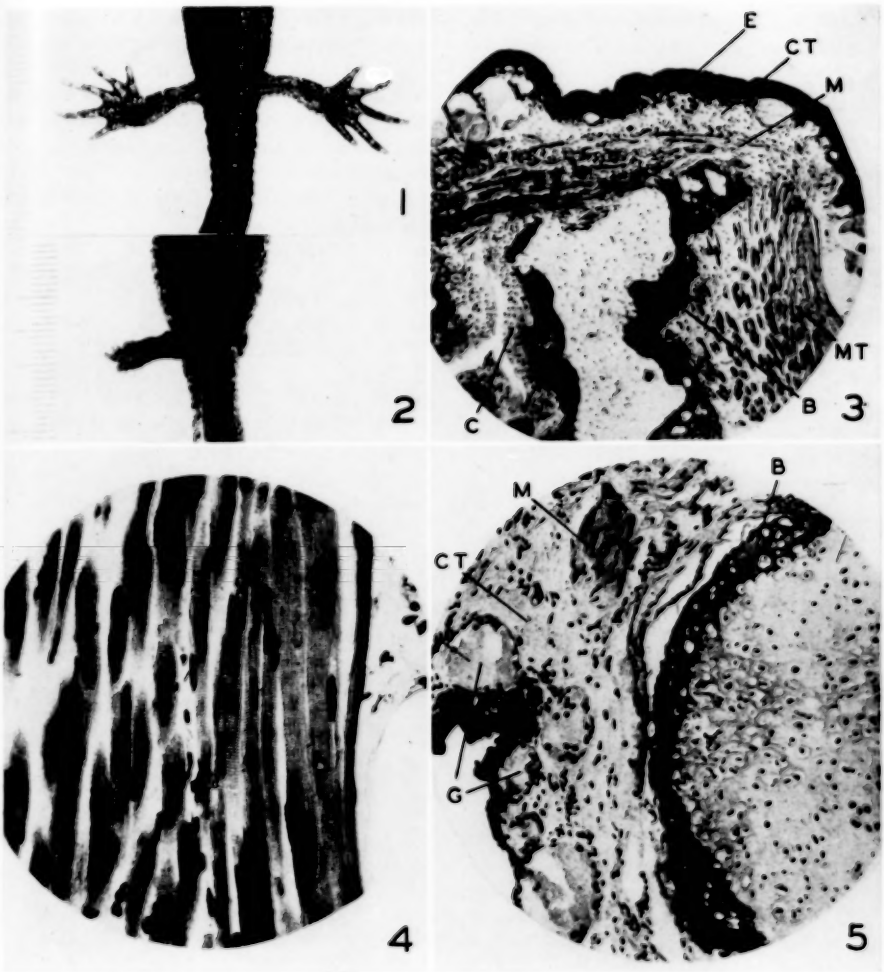


FIG. 8. INHIBITION OF REGENERATION IN X-RAYED ADULT LIMBS OF TRITON CRISTATUS

1. Posterior limbs of triton, one year after the irradiation of the proximal portion of the right limb with 7000 r.
2. The region of the posterior limbs in the same animal 90 days after amputation of both limbs at equal distances from the body.
3. Part of a longitudinal section through a regenerating limb five months after amputation and eight months after irradiation with 7000 r. E, epithelium over stump of amputation; B, bone; C, cartilage; MT, muscle tissue; CT, connective tissue; M, muscle fibers growing into connective tissue. × 50.
4. Another part of the same section. Muscle tissue. × 400.
5. Part of a section through the proximal region of the right posterior limb 5 years and 64 days after irradiation with 3750 r, and two years after a second amputation in the same region. The first amputation was made after irradiation. SG, subcutaneous glands; CT, connective tissue; M, muscle tissue; B, bone. × 50. (After V. V. Brunst, 1938a, 1944).

Similar results have been obtained in a number of invertebrates; irradiated organisms remained alive for a variable period of time, although cell division and regeneration were suppressed (in *Tubularia crocea*, Curtis and Ritter, 1927; in *Planaria*, Weigand, 1930; in *Tubifex*, Stone, 1932; in *Lumbriculus*, Turner, 1935). Irradiated trypanosomes were found to retain their mobility

but to lose their ability to divide (Halberstädter, 1914). Irradiated *Polonium* and *Polytoma* (Protozoa) also retained their mobility and ability to grow, but no division was observed after treatment (Holweck and Lacassagne, 1931). The division of *Paramaecium caudatum* is suppressed by two-thirds of the lethal dose of x-rays. The treated individuals continue, however, to live, and, furthermore, increase in size (Back, 1939). Irradiation does not kill the spermatozoa of *Arbacia*. They move normally and fertilize the eggs. It is not until the first cleavage stage that it is possible to observe the effects of x-ray treatment (Hertwig, 1911; Henshaw, 1940). The results of all these experiments show that the amount of treatment sufficient to suppress proliferation differs considerably from the lethal dose, being much less (see also Belluci, 1939; Packard, 1945).

Two possibilities arise with the passage of time. First, if the irradiated extremities remain alive for very long periods (a year or more), very late radiation reactions may conceivably arise. Second, the regeneration capacity might be restored, at least partly, after a certain lapse of time. The first possibility is particularly likely because of the paradoxical cases of delayed reaction to irradiation described by Matas (1925). According to him, a lethal gangrenous dermatitis in a man was observed four years after irradiation. The following experiment was therefore performed upon *Triton cristatus* (Brunst and Scheremetjewa, 1937a). In several individuals the right hind limb was irradiated with 7000 r units. For one entire year no difference was to be observed in the appearance or function of treated and control limbs (Fig. 8, 1). After the amputation, regeneration took place normally on the control side but was suppressed on the irradiated side (Fig. 8, 2). These experiments suggest that the alterations caused by irradiation in adult tissues are permanent. Despite the unimpaired viability of the limb, its regeneration capacity had been entirely destroyed. The altered properties of the limb became manifest only after the amputation, when a regeneration blastema should normally be formed. After the year period (one year in triton's life being equivalent to not less than four in the life of a person) no delayed reaction analogous to that described by Matas, and no restoration of regenerative capacity was observed.

Histological examination of the stumps of *Triton cristatus* made after more or less prolonged time intervals following irradiation has shown that after a sufficiently heavy treatment tissue regeneration is also suppressed (Brunst, 1938, 1944). As an example may be cited the structure of the distal part of a stump of triton irradiated with 4000 r-units of x-rays. Three months after the treatment, the limb was amputated, but no regeneration was observed. Eight months after the treatment another amputation at a more proximal level was made. Histological study of the amputated piece showed the plane of the first amputation to be clearly visible, as the distal edge of severed bone remained without change and showed no sign of regeneration of bone or cartilaginous tissues (Fig. 8, 3). The distal surface of the nonregenerating stump was covered with a normal epithelium, under which was a small amount of connective tissue, and a few striated muscle fibers and blood vessels. The appearance of the treated tissues does not differ from that of the control animals. The striated muscles possess typical cross striations and longitudinal fibers, and the nuclei look normal (Fig. 8, 4). Mitotic figures were not found in any tissues, except the epithelium. Numerous normal mitotic figures were observed in the latter. However, despite the mitotic activity in the epithelium, no regenerative blastema was formed. Such irradiated tissues retain their normal appearance for an unlimited time. For example, normal-looking tissues were found in an animal that had lacked regeneration capacity for five years and 65 days after the irradiation. No regeneration took place in this animal after two successive amputations. The skeleton of the limb was shortened to the proximal epiphysis of the femur (Fig. 8, 5). The amputation site was covered with skin containing normally developed subcutaneous glands. No mitoses were found (Brunst, 1938, 1944).

Many authors have pointed out that no visible structural changes are seen in the irradiated tissues, and that nevertheless the cells of these tissues have lost the ability to divide and the organs their ability to regenerate. Thus, a histological study of treated septa of *Tubifex* showed no visible alterations, although they had lost the ability to form neoblasts (Stone, 1932). No changes in somatic cells have been found in planarians dying one month after irradiation. Mitotic figures were, however, absent; and sex cells showed signs of degeneration (Bardeen and Baetjer, 1904). Within a certain range of doses of radiation,

rat spermatozoa remain morphologically normal and yet are incapable of giving rise to viable offspring (Wattenwyl, 1941).

D. Comparison of the influence of x-rays on the tissues of adult limbs and on the tissues of regeneration buds

As has been shown above, irradiated and control adult limbs do not differ materially in histological structure. The lack of growth in the tissues of adult control limbs, indicated by exceedingly rare mitoses, is responsible for the fact that no difference was observed in the histological structure of untreated and irradiated limbs. It is especially interesting to compare the structure of a control regenerating bud, normally having many mitotically dividing cells, with a radiated regenerating bud. The irradiated buds stop growing and usually undergo a process of reduction, but in rare instances no reduction takes place. Examination of such nonreducing buds revealed the following: a 2 mm. long bud, preserved two months after a heavy treatment (15,000 r), was covered with a single layer of epithelium; the distal end of the severed bone showed a slight proliferation of cartilage, formed, presumably, during the postradiation latent period; the entire regeneration bud was filled with loose connective tissue; prochondral tissue was lacking; and not a single mitosis was found (Fig. 9, 1). Another regenerating bud, 1.3 mm. long, preserved a year after amputation and two years after irradiation with 3,750 r, was filled with loose connective tissue and a few muscle fibers. The bud was covered by typical old skin with a well developed connective tissue layer and subcutaneous glands (Fig. 9, 2). No mitoses were found (Brunst, 1938, 1944).

Such pictures may be compared with that found in the normal regeneration process. For example, a 26-day-old regenerating bud, 3.2 mm. long, was covered by epithelium with subcutaneous glands in process of formation; a strand of prochondral tissue extended from the distal end of the cartilage to the tip of the regeneration bud; and many mitoses were found in the epithelium, prochondral tissue, cartilage, and connective tissue. The whole regeneration bud was in the midst of rapid growth (Fig. 9, 3).

Thus the effect of x-rays on regenerating or on adult extremities manifests itself as a complete suppression of cell division.

THE SOURCE OF CELLS FOR THE REGENERATION BLASTEMA

The following three hypotheses concerning the origin of the cellular constituents of the regeneration blastema have been suggested. First, the regeneration blastema is formed exclusively by mobile elements derived from the blood stream (hematogenic origin: Colucci, 1886; Fritsch, 1911). Second, the origin of the regeneration blastema is mixed, being derived from blood as well as from local tissue cells (histo-hematogenic origin: Hellmich, 1930; Kazancev, 1934; and others). Third, the regeneration blastema is formed exclusively from local cellular elements (histogenic origin: Weiss, 1925; Böhmel, 1929; and others).

Hertwig (1927) transplanted limbs of haploid triton larvae into diploid larvae of the same age. After the establishment of the transplants, amputations were made. The regenerating bud consisted sometimes of diploid, sometimes of haploid, and sometimes of mixed cells. According to Hertwig, formation of the regeneration blastema can take place, in cases when the local materials are inadequate, at the expense of cells derived from incoming wandering elements.

Studies of the effects of x-rays on regeneration shed light on the problem of the origin of the regeneration blastema. Normal regenerating structures have been observed during the survival period in individuals given a lethal dose of general body irradiation with x-rays, provided that the regeneration bud was protected from the rays by leaded rubber (Litschko, 1930, 1934). It has already been pointed out above that the regeneration capacity of *Triton cristatus* limbs is entirely destroyed by local irradiation (Brunst and Chérémétieva, 1936). These facts argue in favor of a local origin of the regeneration blastema.

The experiments which are most conclusive in this respect are those in which the regeneration capacity was destroyed in a part of a limb and preserved in another part of the same limb (Brunst and Scheremetjewa, 1937a). The proximal part of a limb of *Triton cristatus* was irradiated with 7000 r units, and part of the distal portion was then amputated. Regeneration took place in the part which was not directly irradiated, although this part received its blood and nerve supply through the irradiated portion. In all treated animals, without exception, completely normal regeneration took place, differing in no way from the

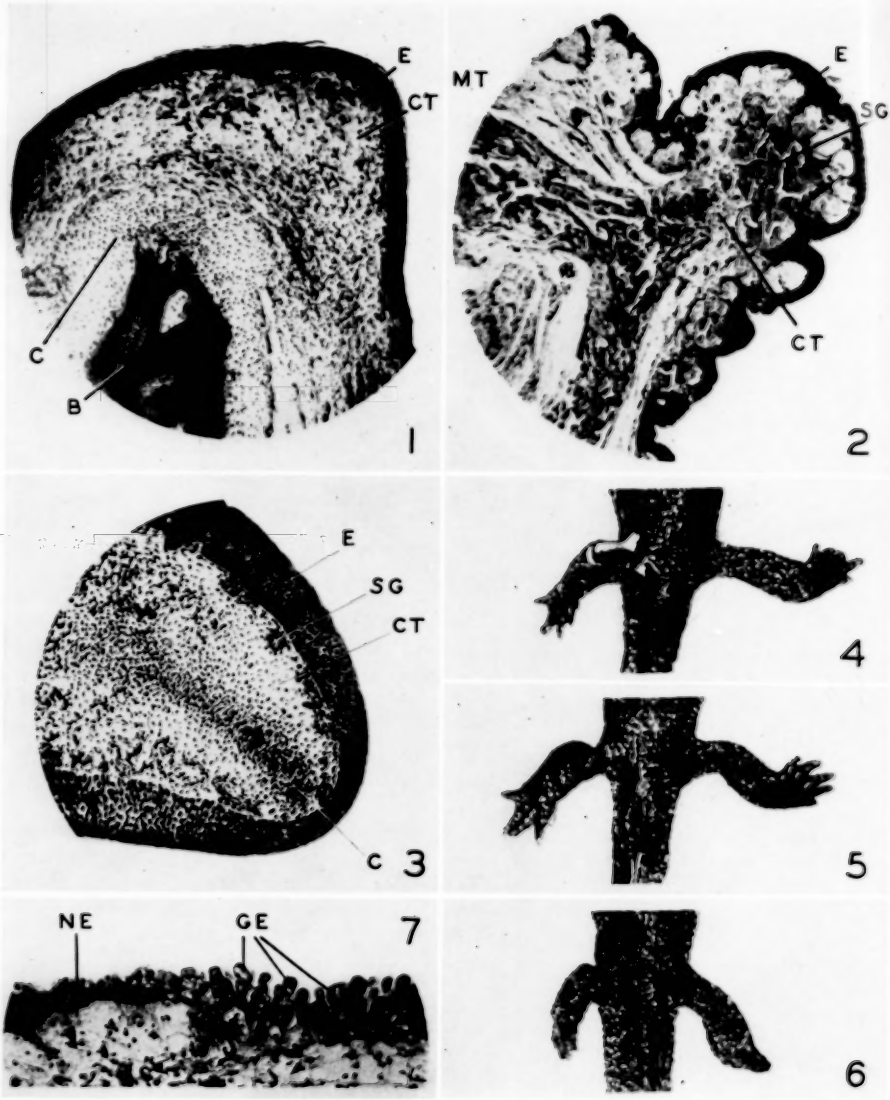


FIG. 9. INHIBITION OF GROWTH OF A REGENERATIVE BUD BY X-RAY TREATMENT AND LOCAL ORIGIN OF A REGENERATIVE BLASTEMA IN TRITON CRISTATUS; PATHOLOGICAL MODIFICATIONS OF CELLS CAUSED BY X-RAYS IN A TADPOLE OF PELOBATES FUSCUS

1. Part of a section through a regenerative bud of triton two months and 13 days after amputation and one month and 18 days after irradiation with 15,000 r. E, epithelium; B, bone; C, cartilage; CT, connective tissue. × 50.

2. Part of a section through a regenerative bud of triton one year after a fourth amputation and two years after irradiation with 3750 r. Irradiation one month after first amputation. E, epithelium; MT, muscle tissue; CT, connective tissue; SG, subcutaneous gland. × 50.

3. Part of a section through a normal regenerative bud of a triton limb 26 days after amputation. E, epithelium; SG, subcutaneous gland; CT, connective tissue; C, young cartilage tissue (prochondral tissue). × 50.

4. Region of the posterior limbs of triton four months after irradiation of the proximal part of the right limb with 7000 r, ventral aspect (right limb is on the left side of the figure). The *femur* is broken and protrudes through soft, necrotic tissues of the treated part. Normal regeneration (three months after amputation of both limbs) in the distal part.

5. The same, two months and 10 days later. Necrosis has ceased, and the wound is covered with epithelium. Ventral aspect.

6. The same, three months and 12 days later. Normal regeneration 59 days after second amputation of both limbs in the distal part. Ventral aspect. (After V. V. Brunst, 1938).

7. Tail epithelium after irradiation with 3750 r in a tadpole of *Pelobates fuscus*. NE, normal epithelium; GE, pathological (giant) epithelium. × 116. (After E. A. Scheremetjewa and V. V. Brunst, 1933).

situation on the control side. In consequence of such a large dose as 7000 r units, necrosis of the irradiated part of the limb was observed in a few of these animals. Most noteworthy was one specimen in which the proximal part of the limb was so severely injured that it became necrotic, and the *femur* broke and protruded (Fig. 9, 4). Two months later, the necrotic process had stopped completely, and the wound was completely epithelized. The limb was at this time joined to the body only by a thin, soft stalk. Though it did not move, it preserved normal sensitivity. Despite the severe disturbance in the proximal portion, regeneration of the distal part took place quite normally (Fig. 9, 4 and 5; Fig. 10). Regeneration

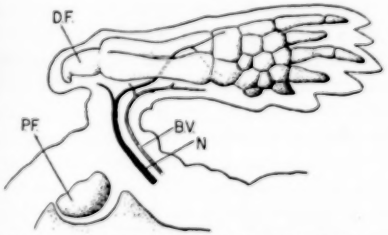


FIG. 10. LOCAL ORIGIN OF A REGENERATIVE BLASTEMA IN TRITON CRISTATUS

Reconstruction of the skeleton, nerve, and blood vessels of the irradiated limb shown in Fig. 9 (4–6), fixed for examination after the end of experiment. DF, distal epiphysis of femur; PF, proximal epiphysis of femur; N, nerve; BV, blood vessel. (After V. V. Brunst, 1938).

occurred normally also after a second amputation of the distal part (Fig. 9, 6).

The regeneration capacity in *Triton cristatus* may be destroyed by a local x-ray treatment simultaneously in the proximal and distal parts of a limb, but may nonetheless be preserved in a small intermediate section, in the region of the knee joint, that has been protected from the radiation (Scheremetjewa and Brunst, 1938). No regeneration was observed subsequently, either when an amputation was made in the distal irradiated part or in the proximal irradiated part. Yet completely normal regeneration was observed following amputation through the middle section (Fig. 11).

Conversely, after irradiation of the knee-joint region in larvae of *Eurycea bislineata* (Butler and O'Brien, 1942), normal regneration was observed in the distal and proximal parts of the limb, but none occurred when the amputation

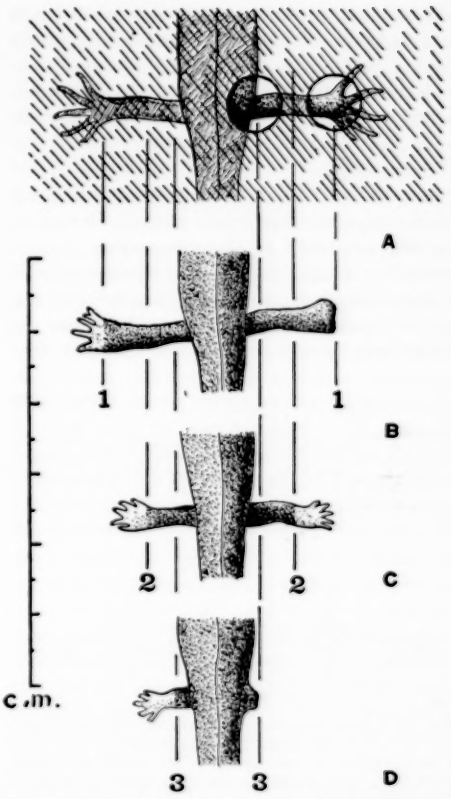


FIG. 11. LOCAL ORIGIN OF A REGENERATIVE BLASTEMA IN TRITON CRISTATUS

Schematic drawing of hind limb region made from successive photographs of the same animal.

A. Irradiation of the proximal and distal parts of the right limb, the two rings showing the position of localizing openings during the irradiation. The hatching symbolizes the lead cover protecting the remainder of the body from the x-rays. The broken lines (1, 2, 3) show the positions of the three successive amputations of the limbs.

B. The results of irradiation of the distal part of the right limb and protection of left one. 118 days after treatment and 100 days after the first amputation of both limbs in the distal portion.

C. The results of protection of the middle part of the right limb and the entire left limb. 253 days after treatment of the proximal and distal parts of the same limb and 109 days after the amputation of both limbs in the middle portion.

D. The results of irradiation of the proximal part of the right limb and protection of the left one. 379 days after the treatment and 70 days after the amputation of both limbs in the proximal portion. (After E. A. Scheremetjewa and V. V. Brunst, 1938).

was made in the region of the knee joint (Figs. 12, 13).

Transplantation of a normal regeneration bud into an irradiated limb gives normal regeneration (Butler, 1935). Conversely, irradiated regeneration buds which failed to grow in their original location failed to develop in the new location as well, when transplanted into normal, untreated limbs (Brunst, 1938).

The results of all these experiments with x-ray irradiation agree completely with the theory of regional autonomy of the regeneration process. According to this theory, the characteristics of a regenerating structure in the *Amphibia* do not depend upon the organism as a whole, but are determined by the properties of the part that gives rise to the regenerate. The regenerative blastema is formed entirely from local cellular elements (Weiss, 1927; Vallette, 1929; Guyénot and Ponse, 1930; and others).

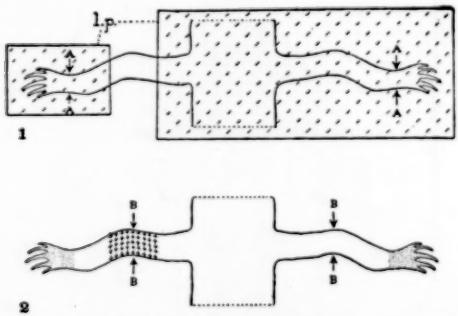


FIG. 12. LOCAL ORIGIN OF A REGENERATIVE BLASTEMA IN EURYCEA BISLINEATA

1. Diagram of arrangement for localized irradiation. l.p, lead plate. Arrows (A) indicate level of first amputations.

2. Same larva 3 weeks after radiation and first amputations. Arrows (B) show level of second amputations. (After E. G. Butler and J. P. O'Brien, 1942).

MODE OF ACTION OF X-RAYS IN SUPPRESSING REGENERATION

The fact that x-rays suppress the regenerative process is, then, well established. But the mode of action of this agent is still not clear. The x-ray injury of the treated organ is obviously a subtle reaction, since these injuries allow the treated organ to stay alive for considerable period of time. The irradiated limb differs obviously from the normal in one way only, namely, in that it lacks regenerative capacity. This subtle but irreversible, table alteration can be induced by some influence of x-rays either on cell structure or cell metabolism, or upon both. Therefore, in order to approach an understanding of this problem, the results of numerous investigations in this field have to be considered. Despite the great number of papers dealing with this problem, no complete agreement has been achieved until recently.

Some investigators have regarded the nuclei and mitotic mechanism as most sensitive (Bergonié and Tribondeau, 1906; Bardeen, 1909; O. Hertwig, 1911; P. Hertwig, 1911; Payne, 1913; Grasnick, 1917; Packard, 1914, 1915, 1918; Mohr, 1919; G. Hertwig, 1920; Alberti and Politzer, 1924; Reiss, 1925; Tschassownikow, 1928; Politzer, 1930; Spear, 1932, 1946; Fuchs and Politzer, 1932;

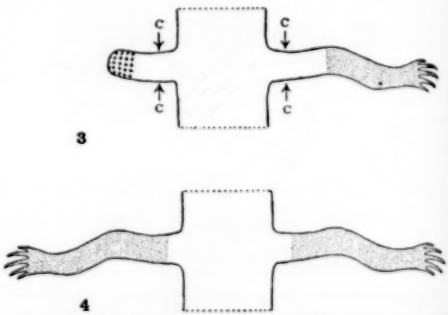


FIG. 13. LOCAL ORGIN OF A REGENERATIVE BLASTEMA IN EURYCEA BISLINEATA

3. Larva 9 weeks after second amputations. Arrows (C) show level of third amputations.

4. Same larva 4 weeks after third amputations. (After E. G. Butler and J. P. O'Brien, 1942).

Mottram, 1933; Combs and Gravett, 1937; Luther, 1939a; Wottge, 1939; Petrova, 1942; Lavedan, 1945; Lea, 1947; and others). Others have found the cytoplasm to be most sensitive (Nürnberger, 1923; Weil and Frenkel, 1926; Jansson, 1926; Jasvoin, 1926; and others). The sensitivity of mitochondria has been emphasized by Wail and Liberson (1926), Nadson and Rochlin (1933), Joyet-Lavergne (1938), and Del Buono (1940). When observed in vivo, the cell nucleus seems unaffected by x-rays, while the cytoplasm is clearly altered (Jansson, 1927). Profound changes in the nucleus soon arise, particularly at mitosis. Packard (1931) reached the following conclusion: "Although we can detect changes in one part of the cell before some other portion is altered, this is not proof that the one is more severely damaged than the other, nor can we judge the extent of

the injury by the appearance of the cell at any particular moment. One that is to all appearances moribund may recover, while another that looks normal after exposure may die later" (p. 256). The changes noticeable in the cytoplasm are reversible (Caspari, 1926; Packard, 1926), and the mitochondria and Golgi bodies broken down by the irradiation are reformed (Hirsch, 1931; Fogg and Wanen, 1937). If, however, the alternations in the cytoplasm produced by very heavy treatment are too great, they become irreversible, and the cell dies (Ralston, 1939; Petrova, 1942). According to Henshaw (1938), Ralston (1939), and others, the suppression of the ability of cells to divide depends upon changes in the nuclei.

In analogy with the arrest of body growth conditioned by the abnormal metabolism that is caused by pathological changes in the endocrine apparatus, it can be supposed that x-rays acting on the cell lower the metabolic rate in the treated organ to such an extent that no cell division, and consequently no growth, can take place.

As to the influence of x-rays on metabolism there are the following opinions. Some authors have concluded that irradiation reduces the rates of respiration and glycolysis (Bersa, 1927; Adler, 1930; Grabtree, 1932; Bodine and Evans, 1934; Evans, 1934; Joyet-Lavergne, 1938; Provenzale, 1942; and others). Others found an increase in the respiration rate (Kimura, 1919; Heeren and Pansdorf, 1931; and others). Still other investigators have considered x-ray effects on metabolism to be unproven (Holthusen, 1921; Boell, Ray, and Bodine, 1937; Goldman, 1943; and others). Krontowski and Lebensohn (1932) treated tissue cultures with radium and found that despite the suppression of growth in irradiated tissue cultures, the rate of glycolysis remained at about 80 per cent of normal. Particularly important is the conclusion of Erdman (1934) that growth always stops before there is a drop in the metabolic rate. Chesley (1934) came to an analogous conclusion. He pointed out that abnormalities in embryonic development appear before the decrease in respiratory rate. The same author showed that eggs of *Arbacia* and *Chaetopterus*, the development of which had been arrested by x-ray treatment, did not show changes in respiration rate.

Finally, some observations on pathological modifications of cells caused by x-ray treatment in different tissues of various organisms, such as algae (Pietschmann, 1937), insects (Mohr, 1919; Helwig, 1933; Dererer, 1940), amphibians (Scheremetjewa and Brunst, 1933; Brunst, unpublished), and mammals (Maximov, 1923), show that the individual cells continue to grow in size despite suppression of their mitotic activity. These cells become quite large and frequently possess two or several nuclei (Fig. 4, 3 and Fig. 9, 7). Perhaps the binucleate cells described by many authors in irradiated tissues are incipient cells of such a kind (Afanassieva, 1936; Atabekova, and others). The increase in cell size may possibly be explained on the basis of an active metabolism (see also Back, 1939). According to Lavedan (1945), most investigators are inclined to think that x-rays scarcely affect metabolic processes. Lamarque's opinion (1942) is that if metabolic changes are observed following large doses of x-rays, this is to be interpreted not as a direct effect of the rays but as a result of injuries to the cells. Obviously the changes that some investigators have observed in the metabolic rates following x-ray treatments are not the primary causes of the other responses of the organism to irradiation.

It appears that only one hypothesis explains most of the well established facts. If the dosage of x-rays is not high enough to kill the cells outright, no irreversible lethal changes are produced in the cells. However, subtle irreversible changes are produced which result in the suppression of mitosis. The mechanism of this process cannot be elucidated now. Its explanation will require a much more detailed knowledge of the delicacies of the structure of the living cell, as well as a much more profound understanding of the nature of the biological effects of x-rays.

It is possible that recent investigations of the action of x-rays upon the nucleic acid metabolism of cells may be an aid in the solution of this problem. It has been found that x-rays inhibit nucleic acid metabolism. Furthermore, it is significant that nucleic acid metabolism plays a fundamental role in mitotic division. This may explain the suppression of mitotic activity by x-ray irradiation (Mitchell, 1943; Stowell, 1945; Taylor, Greenstein, and Hollander, 1947; and others).

THE INFLUENCE OF X-RAYS ON GROWTH AND DIFFERENTIATION DURING REGENERATION

One of the oldest and most important generalizations in the field of x-ray biology is the law of Bergonié and Tribondeau (1906), which states that x-rays have the greatest effect on cells with

a high reproductive capacity and that are least differentiated, and thus more like the embryonic cell types. Thus immature sex cells are among the most sensitive. The literature dealing with x-ray effects on sex cells is enormous. Among the classic studies in this field are those of Bergonié and Tribondeau (1904, 1906a, b) and others. The sensitivity of undifferentiated cells to x-rays has been pointed out by many authors (Hertwig, 1911; Curtis and Hickman, 1926; Stone, 1932; Turner, 1935; Scheremetieva, 1937; Greite, 1940; Evans, 1941; and others). According to these authors, the sensitivity of tissue is dependent upon the degree of its differentiation and the mitotic activity of the constituent cells. Tissues and organs have been graduated according to their x-ray sensitivity by various authors as follows (Table 1):

TABLE 1

Degrees of sensitivity of tissues to X-rays

RIEDER ROSENTHAL 1922	SCHEREMETJEWA AND BRUNST 1933	CLARK 1934	ELLINGER 1941
1. Epithelium	1. Epithelium	1. Epithelium	1. Lymphoid cells
2. Connective tissue	2. Connective tissue	2. Blood vessels	2. Epithelial cells
3. Muscles	3. Muscles	3. Connective tissue	3. Connective tissue cells
4. Blood vessels	4. Nerve	4. Muscles	4. Muscle cells
5. Nerve		5. Nerve	5. Bone cells
			6. Nerve cells

The most detailed picture of the radiation sensitivity of various tissues and organs has been given by Warren (1936). According to this author the bone-marrow cells, intestinal crypt epithelium, lymphocytes, and lymphoid structures have the highest sensitivity. The gonadal cells, especially the immature forms, are only slightly more resistant. A moderate sensitivity characterizes the thymus, the stomach, colon, bladder and salivary epithelia, blood vessel endothelium, and connective tissue cells. Next in order of sensitivity are: the mucosa of the mouth, esophagus, rectum, vagina, pleura, and skin epithelium. The muscles, cartilage, bone cells, and stroma cells of testes and ovary are somewhat more resistant to radiation damage. Most resistant are: red blood cells, adult sperm cells, adult thyroid, adult pituitary, adult specialized connective tissue structures, brain and nerve cells. The most highly differentiated cells which are incapable of dividing, for example, nerve cells, are thus most resistant. Ganglion cells are equally as resistant as those of the central and peripheral nervous system (Caspari, 1926; Zimmern and Chavany, 1931; Scheremetjewa and Brunst, 1933; Clark, 1934; Ellinger, 1941; Campbell, Stanley, and Novick, 1946; and others). On the contrary, embryonic nerve tissue is one of the most sensitive to x-rays (Bagg, 1920; Caspari, 1926; and others).

Age changes in the sensitivity of tissues have been indicated by many authors. The older the embryo, the more resistant its tissues become (Winkler-Junius and Plaats, 1929; Olivieri, 1921; Toumanoff and Veretennikoff, 1930; Moore, 1932; Henshaw, and Henshaw 1933; Scott, 1934; Millwee, 1934; Sheremetieva, 1937; and others). *Daphnia* eggs in the brood chamber are injured by very weak doses which have no effect on the mother (Snider and Kersten, 1935). Irradiation of 18-hour-old *Daphnia* embryos is lethal, while 32-hour-old embryos are only slightly injured by the same dose (Snider and Kersten, 1936). "The lethal dose for the freshly hatched axolotls (150 r) is only one half of the lethal dose for the animals that lived 20 days after hatching (300 r) and only one third of the lethal dose for the axolotls which lived for 30 days after hatching (450 r). The dose which is lethal for the freshly hatched axolotls, has no marked influence whatever upon the animals that survived for 30 days" (Sheremetieva, 1937, p. 162). Developing *Drosophila* eggs treated with 190 r units die, while the lethal dose for young larvae is 1300 r and for adults 100,000 r (Mavor, 1927; Packard, 1945). "In general, sensitivity during development decreases as the age of an individual increases" (Spear, 1946, p. 8). The only contradictory data known to the reviewer are those of Strangeways and Fell (1927), who state that 6-day-old chicken embryos are more sensitive than 25-hour embryos.

Some authors believe that the law of Bergonié and Tribondeau is generally valid, even though not applicable in some cases (Packard, 1931, 1945). Certain exceptions, like rapidly dividing bacteria and yeasts, are not really contradictory to this law. The high resistance of microorganisms and of cells in tissue cultures is a well established fact (Polzien, 1932; Gregori, 1938; Petrova, 1940; Doljanski and Goldhaber, 1942; Back and Halberstaedter, 1945; and others). According to Spear (1946), the dose necessary to kill 50 per cent of the samples of organisms or to reduce their growth to half that of controls is as follows:

Organism	*Doses in r units*
Eggs of *Calliphora*	40
Eggs of axolotl	50
Eggs of *Drosophila*	190
Eggs of *Ascaris*	1,000
Larva of *Drosophila*	1,300
Bacterium coli	5,100
Saccharomyces	42,000
Imago of *Drosophila*	95,000
Bacterium mesentericus	200,000
Colpidium colpoda	330,000

The real nature of these exceptions is not clear at present, because the mechanism of x-ray effects in organisms is still obscure. It would appear that isolated cells are less sensitive than cells in a tissue (Schneider, 1926). Chemical substances which increase the sensitivity of an organism to irradiation have no effect in tissue cultures (Thomas and Chevroment, 1938).

The overwhelming weight of evidence on the effects of x-rays on multicellular organisms in vivo favours the Bergonié and Tribondeau law. As pointed out above, the cells are less sensitive the older and more differentiated they are. There appears to be some evidence, however, that x-rays may exert an effect on the processes of cellular differentiation also (Butler, 1933, 1935; Puckett, 1934, 1936a, b, 1937; Butler and Puckett, 1940). The basis of this view is that no differentiation processes take place after irradiation in a regenerating bud in an amphibian larva (Butler, 1933, 1935). Puckett (1936b) has studied the influence of x-rays on regeneration in the hydroid *Pennaria tiarella*, and came to the conclusion that x-rays suppress cellular differentiation without affecting cell multiplication. He found in irradiated hydroids large shapeless masses of cells which fail to regenerate new hydranths. It seems possible, therefore, that weak x-ray treatments may permit cell division to continue, although these cells may be sufficiently injured to disturb the morphogenetic processes. Such disturbances in morphogenesis and in growth have also been noted, following weak treatments, in regenerating amphibian limbs (Brunst, 1937). On the other hand, some observations support the view that processes of differentiation are not directly affected by x-rays. The differentiation of organs is completed after irradiation of chicken embryos (Vernoni, 1911). Likewise, no effect of irradiation on cell differentiation is recorded in mammalian testes (Hertwig, 1938). In the development of *Drosophila*, the resistance to irradiation is greatly increased at the time of gastrulation, which corresponds to the beginning of differentiation processes. The embryo at the time of differentiation is thus less sensitive to irradiation than during the processes of growth and cell division (Henshaw and Henshaw, 1933; Henshaw, 1935). In developing salamander larvae, x-rays completely suppress cell division but do not affect cell differentiation (Luther, 1939). In the x-rayed eyes of two-day-old rats, degeneration appears only in the undifferentiated layers of the retina (Spear, 1946). In the eye of the frog tadpole, where differentiation and proliferative activity are separated in space (the central parts being fully differentiated and functioning while proliferation still continues in the peripheral region), degeneration of cells was observed after treatment only in the peripheral germinative zone (Spear, 1946). From these experiments Spear concluded that "sensitivity to radiation is lost as differentiation proceeds"; and besides this he says, "in certain circumstances radiation may promote the process of differentiation" (p. 9). Studies of the influence of x-rays on the development of the axolotl show very clearly that x-rays do not interfere with the completion of tissue and organ differentiation, and yet suppress cell division and growth. This results in the formation of very small limbs (Fig. 14), whose growth has been arrested while the differentiation of their tissues was completed (Brunst, 1944a).

SUMMARY

1. Usually reaction of the organism to x-ray treatment is observed after a latent period. During this reaction, relatively acute and temporary changes in the treated tissues are observed (a "primary reaction"). Profound alterations of the

cells, particularly those in mitotic division, often cause pathological degeneration (visible injuries) and death of all cells with high sensitivity to x-rays. In many cases the reaction of irradiated tissues is similar to inflammation. In some cases the primary reaction is not observed, in spite of the fact that much later serious alterations in the treated organ may be detected. Some time after the primary reaction has occurred, a stable state, which lasts for an unlimited time, arises in the irradiated organs. The inflammation and

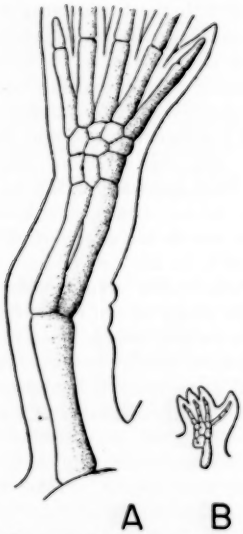


FIG. 14. THE LACK OF EFFECT OF X-RAY TREATMENT ON DIFFERENTIATION OF THE LIMB IN THE AXOLOTL, SIREDON MEXICANUM

Reconstructions of the limb skeletons of the control (A) and of an irradiated animal (B) of the same age, at the same magnification. The inhibition of growth in the irradiated limb is accompanied by almost perfect differentiation of skeleton. (After V. V. Brunst, 1944 -a).

all other phenomena characteristic of the primary reaction disappear before the establishment of this state. It may arise regardless of whether the primary reaction was acute, mild, or absent. The surviving tissues recover their normal appearance but not all of their potentialities (invisible injuries). Their cells have lost the capacity to multiply, and therefore regeneration, or further growth and development are impossible. This reaction has been called the "secondary reaction."

2. Postamputation irradiation of the regenerating limb causes not only an arrest of the regenerative process by usually induces a more or less rapid decrease in size, or reduction, of the treated regenerate. This phenomenon is due basically to an inflammatory process in the irradiated tissues. An active role in this process is played by giant cells (macrophages or polyblasts). These cells migrate to the irradiated zone, probably from the surrounding tissues. The tissues weakened by irradiation are destroyed by macrophages through phagocytosis and lysis. The reduction is a primary, acute reaction to irradiation in amphibian regenerates. It occurs also in developing limbs and tail of irradiated young amphibian larvae. The reduction is a reaction of young tissues to irradiation.

3. Irradiation prior to amputation (treatment of the adult limb) causes no reduction. Adult organs consisting of differentiated cells do not show the acute reaction. The irradiated organs do not differ in appearance from normal ones. However, these organs lose their ability to regenerate.

4. It is possible to destroy by means of local x-ray treatment the regenerative ability both in the proximal and in the distal portions of a limb, while preserving the regenerative capacity in a small intermediate, untreated portion of the same limb. Transplantation of a normal regeneration bud into an irradiated limb results in normal regeneration. Conversely, irradiated regeneration buds which have failed to grow in their original sites, will, when transplanted into normal, untreated limbs, fail to develop in the new location as well. The regeneration blastema is formed from local cellular elements.

5. If the dosage of x-rays is not high enough to kill the cells outright, no irreversible lethal changes are produced in them. A lethal dose for the cells is much greater than that which suppresses cell division, and hence growth, regeneration, and development. Irradiated cells suffer injuries, as a consequence of which they lose the ability to divide. But irradiated organs consisting of the cells which do not divide may persist without change for a very long time (a secondary stable state).

6. The suppression of cell division does not affect the differentiation process. Tissue and organ differentiation in irradiated animals may be completed despite a cessation of growth.

ACKNOWLEDGMENTS

This paper was written in the laboratory of Dr. Myron Gordon of New York Zoological So-

ciety (New York Aquarium), while the author was a Senior fellow of the National Institute of Health, United States Public Health Service (1947–1948).

The reviewer wishes to express his appreciation for the valuable assistance given by Professor Elmer G. Butler of Princeton University, Professor Theodosius Dobzhansky of Columbia University, Dr. Myron Gordon of the New York Zoological Society, Dr. Ross F. Nigrelli of the New York Zoological Society, and Professor Frank H. J. Figge of University of Maryland. The author also wishes to express his indebtedness to Professor E. G. Butler for the original plates of Figures 12 and 13, and to Mrs. Sheremetieva-Brunst for criticism and valuable help in the preparation of the manuscript.

LIST OF LITERATURE

ADLER, K. 1930. Die biologische Wirkung der kurzwelligen Strahlen auf den Stoffwechsel der Zelle. *Strahlentherapie*, 36: 1–31.

AFANASSJEVA, A. S. 1936. Die Wirkung der Röntgenstrahlen auf die Zellelemente vom Sommerweizen *Triticum vulgare*. *Protoplasma*, 25: 77–91.

ALBERTI, W. and G. POLITZER. 1924. Über den Einfluss der Röntgenstrahlen auf die Zellteilung. *Arch. mikr. Anat. Entwmech. Org.*, 100: 83–109.

ALESHIN, B. 1936. Studies on metamorphosis in *Amphibia*. The resorption of larval tails as a process of inflammation. *Arch. Anat. Hist. Embryol.*, 15: 9–70. (Russian).

ATABEKOWA, A. J. 1936. Die Wirkung der Röntgenstrahlen auf die Samen und Keimlinge der Erbsen. *Biol. Zh.*, 5: 99–115. (Russian).

BACK, A. 1939. Sur un type des lésions produites chez *Paramaecium caudatum* par les rayons X. *C.r. Soc. Biol., Paris*, 131: 1103–1106.

——, and L. HALBERSTAEDTER. 1945. Influence of biological factors on the form of roentgen-ray survival curves. Experiments on *Paramecium caudatum*. *Amer. J. Roentgenol. Rad. Ther.*, 54: 290–295

BAGG, H. J. 1920. The action of buried tubes of radium emanation upon normal and neoplastic tissues. *Amer. J. Roentgenol.*, 7: 536–544.

BARDEEN, C. R. 1909. Variation in susceptibility of amphibian ova to the X-rays at different stages of development. *Anat. Rec.*, 3: 163–165.

——, and F. H. BAETJER. 1904. The inhibitive action of the Roentgen rays on regeneration in planarians. *J. exp. Zool.*, 1: 191–195.

BARNES, W. A., and O. B. FURTH. 1943. Studies on the indirect effect of roentgen rays in single and parabiotic mice. *Amer. J. Roentgenol. Rad. Ther.*, 49: 662–681.

BATAILLON, E. 1891. Recherches anatomiques et experimentales sur la metamorphose des Amphibiens anoures. *Ann. Univ. Lyon*, 2: 1–123.

BELLUCI, B. 1939. Beitrag zur Frage des Angriffspunktes der Strahlen an der lebenden Materie. *Strahlentherapie*, 65: 547–568.

BERGONIÉ, J., and L. TRIBONDEAU. 1904. Action des rayons X sur le testicule de rat blanc., *C.r. Soc. Biol., Paris*, 57: 154–158.

——. 1906a. Action des rayons X sur le testicule. *Arch. electr. Med.*, 14: 779–791, 823–846, 874–883, 911–927.

——. 1906b. Interprétation de quelques résultats de la radiotherapie et essai de fixation d'une technique rationelle. *C.r. Acad. Sci., Paris*, 143: 983–985.

BERSA, E. 1927. Strahlenbiologische Untersuchungen. Über den Einfluss der Röntgenstrahlen auf die Atmung der Wurzelspitzen von *Vicia faba*. *Sitz. Akad. Wiss., Wien*, 136: 403–419.

BODINE, J. H., and T. C. EVANS. 1934. Respiration and development of individual mud-dauber larvae following X-irradiation. *Physiol. Zool.*, 7: 550–555.

BOELL, E. J., M. RAY, and J. H. BODINE. 1937. Effect of X-rays on the oxygen consumption of embryonic cells. *Radiology*, 29: 533–540.

BOHMEL, W. 1929. Regeneration nach Entnahme von Skeletteilen beim *Axolotl*. *Arch. Entwmech. Org.*, 115: 464–509.

BOZEMAN, M. L. 1943. Effect of irradiation of oöcytes of *Sciara*. *Genetics*, 28: 71.

BRUNST, V. V. 1926. On the influence of nervous system on regeneration. *Trav. Inst. Zool. Biol. Akad. Sci. Ukraine, Kiev*, 1: 111–132.

——. 1937a. Über die Wirkung der Röntgenstrahlen auf die Skeletentwicklung bei der Regeneration der Tritonextremitäten. *Bull. Biol. Med. exper. Moscow*, 3: 238–241.

——. 1937b. Investigations on the effects of X-rays upon limb regeneration in *Triton*. *Trav. Inst. Zool. Biol. Acad. Sci. Ukraine, Kiev*, 17: 107–135.

——. 1938a. Über den Einfluss der Röntgenstrahlen auf den Prozess der Regeneration. *Trav. Inst. Zool. Biol. Acad. Sci. Ukraine, Kiev*, 18: 50–179.

——. 1938b. The effect of X-rays on the development of the limb in axolotl. *Bull. Biol. Med. exper. Moscow*, 6: 530–532.

——. 1938c. A study of factors influencing the definitive formation of triton tail regenerates after irradiation with X-rays. *Bull. Biol. Med. exper., Moscow*, 6: 527–529.

——. 1941. On the process of reduction of X-radiated limbs in axolotl. *Bull. Biol. Med. exper., Moscow*, 11: 398–400.

——. 1944a. Untersuchung des Einflusses von Rönt-

genstrahlen auf die regenerierenden und erwachsenen Extremitäten bei Urodelen. *Arch. Entwmech. Org.*, 142: 668–705.

——. 1944b. Untersuchung des Einflusses von Röntgenstrahlen auf die Entwicklung bei Amphibien. *Arch. Entwmech. Org.*, 142: 706–729.

——, and E. A. Chérémétieva. 1935a. Influence des rayons X sur la régénération de la queue du *Triton* après une seule irradiation a doses variées. *C.r. Soc. Biol., Paris*, 119: 96–98.

——, and ——. 1935b. Recherches sur l'influence des rayons X sur la régénération de la queue du *Triton* apres une seule irradiation à doses variées. *Arch. Biol.*, 46: 357–368.

——, and ——. 1935c. Influence des rayons X sur la régénération de la queue des tetards. Courbure causée par les rayons X sur les queues régénérées. *C.r. Soc. Biol., Paris*, 119: 189–190.

——, and ——. 1936. Sur la perte local du pouvoir l'igénérateur chez le triton et l'axolotl causée par réirradiation avec les rayons X. *Arch. Zool. exp. Gen.*, 78: 57–67.

——, and E. A. Scheremetjewa. 1933. Untersuchung des Einflusses von Röntgenstrahlen auf die Regeneration der Extremitäten beim *Triton*. *Arch. Entwmech. Org.*, 128: 181–215.

——, and ——. 1937a. Ist es möglich, die Regenerationsfähigkeit einer *Triton* extremität zu vernichten, ohne ihre Lebensfähigkeit zu schädigen? *Bull. Biol. Med. exper., Moscow*, 3: 397–399.

——, and ——. 1937b. Wirkt Röntgenbestrahlung eines Extremitätenteils auf die Regeneratione eines anderen Teils derselben Extremität beim *Triton*? *Bull. Biol. Med. exper., Moscow*, 3: 242–244.

——, and E. A. Sheremetieva. 1937. On the destruction of the regenerative ability of the limb of tritons by X-radiation without impairing its vital capacity. *Trav. Inst. Zool. Biol. Acad. Sci. Ukraine, Kiev*, 17: 81–94.

Butler, E. G. 1931. X-radiation and regeneration in *Amblystoma*. *Science*, 74: 100–101.

——. 1932. On some cellular reactions to X-radiation. *J. Exp. Biol.*, 9: 107–116.

——. 1933. The effect of radiation on the regeneration of the fore limb of *Amblystoma* larvae. *J. exp. Zool.*, 65: 271–303.

——. 1934. The effect of X-rays on tissue regeneration. *Sci. Month.*, 39: 511–518.

——. 1935. Studies on limb regeneration in X-rayed *Amblystoma* larvae. *Anat. Rec.*, 62: 295–307.

——, and W. O. Puckett. 1940. Studies on cellular interaction during limb regeneration in *Amblystoma*. *J. exp. Zool.*, 84: 223–237.

——, and J. P. O'Brien. 1942. Effect of localized X-radiation on the *Urodela* limb. *Anat. Rec.*, 84: 407–413; 466–467.

——, and O. E. Schotté. 1941. Histological alterations in denervated nonregenerating limbs of urodele larvae. *J. exp. Zool.*, 88: 307–341.

Calo, A. 1932. Züchtung von Geweben in Plasma von röntgenbestrahlten Tieren. *Strahlentherapie*, 45: 487–502.

Campbell, B., Stanley C. Peterson and R. Novick. 1946. Early changes induced in Purkinje cells of rabbit by single massive doses of roentgen rays. *Proc. Soc. exp. Biol. Med.*, 61: 353–355.

Canti, R. G., and M. Donaldson. 1926. The effect of radium on mitosis in vitro. *Proc. roy. Soc. Lond.*, B, 100: 413–419.

——, and F. G. Spear. 1928. The effect of gamma irradiation on cell division in tissue culture in vitro. *Proc. roy. Soc. Lond.*, B, 102: 92–101.

——. 1929. Studies on cell division in tissue culture. *J. roy. micr. Soc.*, 49: 120–122.

Carlson, J. G. 1942. Immediate effects of 31 r X-rays on the different stages of mitosis in neuroblasts of *Chortophaga*. *J. Morph.*, 71: 449–462.

Carothers, E. E. 1940. A cytological study of X-rayed grasshopper embryos. *J. Morph.*, 66: 529–559.

Caspari, W. 1926. Physiologie der Röntgen und Radiumstrahlen. *Hb. norm. pathol. Physiol.*, 17: 343–390.

Chesley, L. 1934. The effect of radiation upon cell respiration. *Biol. Bull.*, 67: 259–272.

Clark, G. L. 1934. The effects of X-radiation on cell, structure and growth. A general survey of radiobiology. *Cold Spring Harbor Symp. quant. Biol.*, 2: 249–263.

Colucci, V. 1886. Intorni alla rigenerazione degli arti e della coda nei Tritoni. *Mem. Acad. Bologna*, 6: 501–566.

Combs, J. D., and H. L. Gravett. 1937. The effects of a constant dosage of X-rays during the pre-, post-, and mid-proliferative periods in *Drosophila melanogaster*. *Genetics*, 22: 557–563.

Cox, S. F. 1931. Sensitivity to X-rays of cells in vitro. *Arch. exp. Zellforsch.*, 11: 121–131.

Creighton, M. 1941. The effects of X-rays on mitotic and meiotic chromosomes and cell division in *Chorthippus longicornis* (*Orthoptera*). *J. exp. Zool.*, 87: 347–369.

Crowther, J. A. 1924. Some considerations relative to the action of X-rays on the tissue cells. *Proc. roy. Soc. Lond.*, B, 96: 207–211.

Crummy, P. L. 1935. The inhibition of regeneration by X-rays, in the urodele, *Triturus viridescens*. *Amer. Nat.*, 69: 91–94.

Curtis, W. C. 1936. Effects of X-rays and Radium upon Regeneration. In *Biological Effects of Radiation* (B. M. Duggar, ed.) pp. 411–457. McGraw-Hill Book Co., New York, London.

——, and J. Hickman. 1926. Effects of X-rays and Radium upon regeneration in planarians. *Anat. Rec.*, 34: 145.

——, and R. A. Ritter. 1927. Further studies upon the effects of X-rays on regeneration. *Anat. Rec.*, 37: 128.

DAVISON, C., and F. ELLINGER. 1942. Radiation effects on nervous system and roentgen pigmentation of goldfish (*Carassius auratus*). *Proc. Soc. exp. Biol. Med.*, 49: 491–495.

DEL BUONO, P. 1940. Die Wirkung der Röentgenstrahlen auf die Zelle. *Strahlentherapie*, 67: 83–99.

DERERER, P. H. 1940. The production of giant spermatocytes in *Philosauria cynthia* by means of X-rays. *J. Morph.*, 67: 159–173.

DESSAUER, F. 1931. Ueber primäre Vorgänge der Strahlenwirkung. *Arch. exp. Zellforsch.*, 11: 65–86

——, and W. CASPARI. 1926. Probleme der biologischen Strahlenwirkung. Punktwärme and Nekrohormonhypothese. *Acta Radiol.*, 6: 241–271.

DOLJANSKI, L., and G. GOLDHABER. 1942. Radiological studies on tissue cultures. *Growth*, 6: 235–249.

——. 1943. Delayed lethal effect of X-rays on fibroblasts cultivated in vitro. *Proc. Soc. exp. Biol. Med.*, 53: 114–116.

DUESBERG, J. 1906–07. Contribution à l'étude de phénomènes histologiques de la metamorphose chez Amphibiens anoures. *Arch. Biol.*, 22: 163–228.

ELLINGER, F. 1940. Roentgen-pigmentation in gold fish. *Proc. Soc. exp. Biol. Med.*, 45: 148–150.

——. 1941. *The Biological Fundamentals of Radiation Therapy*. 360 pp. Elsevier Pub. Co., New York.

——. 1945. Lethal dose studies with X-rays. *Radiology*, 44: 125–142.

ERDMANN, K. 1934. Über die Ursache der Wachstumshemmung durch Röntgenstrahlen. *Zool. Anz.* (*Suppl.*), 7: 141–146.

EVANS, T. C. 1934. Respiration and visible development of individual grasshopper eggs following X-irradiation. *Physiol. Zool.*, 7: 556–571.

——. 1941. Sequence of Roentgen ray effects on the development of the grasshopper egg. I. *Physiol. Zool.*, 14: 163–173.

FOGG, L. C., and S. WANEN. 1937. A comparison of the cytoplasmic changes induced in the Walker rat carcinoma 256 by different types and dosages of radiation. I. The Golgi apparatus. *Amer. J. Cancer*, 31: 567–577.

FRITSCH, C. 1911. Experimentelle Studien über Regenerationsvorgänge des Gliedmassenskeletts der Amphibien. *Zool. Jahrb. Abt. allg. Zool. Physiol* 30: 377–472.

FUCHS, H., and G. POLITZER. 1932. Über die Wirkung der Radiumstrahlen auf die Zelltheilung. *Strahlentherapie*, 45: 359–364.

GIESE, A. C. 1947. Radiations and cell division. *Quart. Rev. Biol.*, 22: 253–282.

GLOCKER, R. H., and M. LANGENDORFF. 1933. Gibt es eine obere Dosisgrenze für die biologische Wirkung der Röentgenstrahlen? *Naturwiss.*, 21: 316.

GIDGE, N. M., and S. M. ROSE. 1944. The role of larval skin in promoting limb regeneration in adult Anura. *J. exp. Zool.*, 97: 71–89.

GODLEWSKI, E. 1928. Untersuchungen über Auslösung und Hemmung der Regeneration beim Axolotl. *Arch. Entwmech. Org.*, 114: 108–143.

GOLDMAN, D. 1943. Metabolic changes occurring as the result of deep Roentgen therapy. *Amer. J. Roentg. Rad. Ther.*, 50: 381–391.

GRABTREE, H. G. 1932. Changes in the carbohydrate metabolism induced by radium irradiation of tissues. *Sci. Rep. imper. Cancer Res. Found.*, 10: 33–70.

GRASNIK, W. 1917. Die Wirkung der Radiumstrahlen auf tierische Gewebe. *Arch. mikr. Anat.*, 90: 1–38.

GREGORI, A. 1938. Raggi X "in vivo" ed "in vitro". Azione sul midollo ossea. *Scr. Ital. Radiobiol.*, 5: 263–268.

Greite, W. 1940. Die Wirkung von Röntgenstrahlen auf die Pigmentbildung in der Vogelfeder. *Biol. Zbl.*, 60: 258–267.

GUYÉNOT, E. and K. PONSE. 1930. Territoires de régénération et transplantations. *Bull. biol.*, 64: 251–388.

HALBERSTÄDTER, L. 1914. Experimentelle Untersuchungen an Trypanosomen. *Berlin. klin. Wochenschr.*, 51: 252–253.

HEEREN, J., and J. PANSDORF. 1931. Gewebsatmung nach Röntgenbestrahlung. Experimentelle Untersuchungen am Leber und Niere. *Strahlentherapie*, 42: 307–327.

HEINEKE, H. H. 1914. Zur Theorie der Strahlenwirkung, insbesondere über die Latenzzeit. *Münch. med. Wochenschr.*, Jahrg. 61: 807–810.

HELLMICH, W. 1930. Untersuchungen über Herkunft und Determination des regenerativen Materials bei Amphibien. *Arch. Entwmech. Org.*, 121: 135–203.

HELWIG, E. R. 1933. The effect of X-rays upon the chromosomes of *Circotettix veruculatus* (*Orthoptera*). *J. Morph.*, 55: 265–311.

HENSHAW, P. S. 1935. Changes in susceptibility of *Drosophila* eggs to X-rays. *Radiology*, 24: 438–443.

——. 1938. The action of X-rays on nucleated and non-nucleated egg fragments. *Amer. J. Cancer.* 33 258–264.

——. 1940. Further studies on the action of roentgen rays on the gametes of *Arbacia punctulata*. *Amer. J. Roentgenol. Rad. Ther.*, 43: 907–912.

——. 1944. Experimental roentgen injury. *J. natl. Cancer Inst.*, 4: 503–512.

——, and I. COHEN. 1940. Further studies on the action of roentgen rays on the gametes of *Arbacia punctulata*. *Amer. J. Roentgenol. Rad. Ther.*, 43: 899–906.

——, and C. T. HENSHAW. 1933. Changes in susceptibility of *Drosophila* eggs to X-rays. *Radiology*, 21: 239–251.

HERČIK, F., and M. KLUSAKOVA. 1939. Sur l'influence du facteur espace dans l'irradiation d'un tissu par les rayons α. *C.r. Soc. Biol. Paris*, 130: 379–382.

HERTWIG, G. 1920. Das Radiumexperiment in der Biologie. *Strahlentherapie*, 11: 821–850.

——. 1927. Beiträge zum Determinations und Regenerationsproblem mittels der Transplantation haploidkernigen Zellen. *Arch. Entwmech. Org.*, 111 292–316.

HERTWIG, O. 1911. Mesothoriumversuche an tierischen Keimzellen. *Sitz. ber. konig. preuss. akad. Wiss.*, 34: 844–873.

HERTWIG, P. 1911. Durch Radiumbestrahlung hervorgerufene Veränderungen in den Kernteilungsfiguren der Eier von *Ascaris megalocephala*. *Arch. mikr. Anat.*, 77: 301–312.

HIRSCH, G. C. 1931. Analyse der Restitution des Sekretmaterials im Pankreas mittels Röntgenstrahlen. *Arch. Entwmech. Org.*, 123: 792–821.

HOLTHUSEN, H. 1921. Beiträge zur Biologie der Strahlenwirkung. *Pflug. Arch. ges. Physiol.*, 187: 1–24.

HOLWECK, F., and A. LACASSAGNE. 1931. Essai d'intérprétation quantique des diverses lésion produites dans les cellules par les radiation. *C.r. Soc. Biol. Paris*, 107: 814–817.

JANSSON, G. 1926. Zur Frage der biologischen Wirkung der Röentgenstrahlen. *Finska lökaresällskap. Handl.*, 68: 305–322.

——. 1927. Die Einwirkung der Röntgenstrahlen auf das Zellprotoplasma. *Acta Radiol.*, 8: 427–461.

JASVOIN, G. 1926. Über den zeitliche Eintritt von morphologischen Veränderungen in der Zelle unter dem Einfluss von Röntgenstrahlen und Radon. *Westnik Rentg. Radiol.*, 4: 305–310. (Russian).

JOYET-LAVERGNE, P. 1938. Le méchanisme de l'action des rayons X sur le cytoplasme de la cellule. *C.r. Acad. Sci. Paris*, 206: 1758–1760.

KAZANCEV, W. 1934. Histologische Untersuchung des Regenerationsprozesses an amputierten Extremitäten beim Axolotl. *Trav. Lab. Zool. exper. Acad. Sci. URSS.*, 3: 23–55.

KIMURA, N. 1919. The effects of X-ray irradiation on living carcinoma and sarcoma cells in tissue cultures in vitro. *J. Cancer Res.*, 4: 95–136.

KORSCHELT, E. 1927. *Regeneration and Transplantation*. Bd. I. *Regeneration*. Gebrüder Borntraeger, Berlin.

KOSAKA, S. 1928. Der Einfluss der Röntgenstrahlen auf die Fetten. *Okayama-Igakkai-Zasshi*, 40: 1893–1919.

KRONTOWSKI, A. A., and E. G. LEBENSOHN. 1932. Ueber die Wirkung des Radiums auf den energieliefernden Zellstoffwechsel. *Arch. exp. Zellforsch.* 13: 405–411.

LAMARQUE, P. 1942. *Les bases physiques et biologiques de la roentgentherapie*. 530 pp. Masson, Paris.

LAVEDAN, J. 1945. *L'action des radiations sur la cellule normale*. 128 pp. Gauther-Villars, Paris.

LEA, D. E. 1947. *Action of radiation on living cells*. 402 pp. The University Press, Cambridge, Eng.

LEBLOND, C. P., and G. SEGAL. 1942. Differentiation between the direct and indirect effects of roentgen rays upon the organs of normal and adrenalectomized rats. *Amer. J. Roentg. Rad. Ther.*, 47: 302–306.

LEVINE, W. T. 1931. Pigmentary reaction in *Rana clamitans* larvae following treatment with X-rays. *Proc. Soc. exp. Biol. Med.*, 28: 594–596.

LITSCHKO, E. J. 1930. Observations sur la régénération des extremités des axolotls après l'action des rayons X. *C.r. Acad. Sci. URSS*, A: 549–551.

——. 1932. Further observations on the effect of X-rays on regeneration in Axolotl. *C.r. Acad. Sci. URSS.*, A-3: 65–70. (Russian).

——. 1934. Einwirkung der Röentgenstrahlen auf die Regeneration der Extremitäten, des Schwanzes und der Dorsalflosse beim Axolotl. *Trav. Lab. Zool. exp. Acad. Sci. URSS.*, 3: 101–140. (Russian).

——. 1935. Zur Frage der Histogenesis und des späteren Schicksals der Osteoklasten während der Regeneration der Extremitäten beim Axolotl nach Röntgenbestrahlung. *Trav. Lab. Zool. exp. Acad. Sci. URSS.*, 4: 169–193. (Russian).

LOVE, W. H. 1934. Sensitivity of dividing cells to radiation. *Nature, Lond.*, 134: 252.

LUTHER, W. 1938. Radiosensibilität and Zellteilung. I. Versuche über Froscheiern. *Strahlentherapie*, 62: 436–449.

——. 1939a. Die Strahlenwirkung auf Amphibienhaut vor und nach Metamorphose. *Naturwiss.*, 27: 713–720.

——. 1939b. Die Wirkung der Röntgenstrahlen auf die Zellteilung. *Strahlentherapie*, 66: 40–49. . .

MARQUARDT, H. 1938. Die Röntgenpathologie der Mitose. *Z. Bot.*, 32: 401–482.

MATAS, R. 1925. Remarks on the delayed or remote appearance of X-ray burns after long periods of latency. *Amer. J. Roentgenol. Rad. Ther.*, 13: 37–40.

MAVOR, J. W. 1927. A comparison of the susceptibility to X-rays of *Drosophila melanogaster* at various stages of its life cycle. *J. exp. Zool.*, 47: 63–83.

MAXIMOV, A. 1906a. Über entzündliche Bindegewebeneubildungen beim Axolotl. *Beitr. path. Anat. allg. Path.*, 39: 333–372.

——. 1906b. Ueber die Zellformen des lockeren Bindegewebe. *Arch. mikr. Anat.*, 67: 680–750.

——. 1923. Studies on the changers produced by

roentgen rays in inflamed connective tissue. *J. exp. Med.*, 37: 319–340.

——. 1932. The Macrophages or Histiocytes. In *Special Cytology* (E. V. Cowdry, ed.) 2nd ed., pp. 709–766. P. B. Hoeber, New York.

——, and W. Bloom. 1942. A *Textbook of Histology*. 695 pp. W. B. Saunders Co., Philadelphia & London.

Millwee, R. H. 1934. The influence of the antiquity of the cell upon cell resistance to radium and X-rays. *Radiology*, 22: 74–76.

Mitchell, J. S. 1943. Metabolic effects of therapeutic doses of X and gamma radiations. *Brit. J. Radiol.*, 16: 339–343.

Mohr, O. L. 1919. Mikroskopische Untersuchungen zu Experimenten über den Einfluss der Radiumstrahlen und der Kältewirkung auf die Chromatinreifung. *Arch. mikr. Anat.*, 92: 298–368.

Moore, W. G. 1932. The effects of X-rays on fertility in *Drosophila melanogaster* treated at different stages in development. *Biol. Bull.*, 62: 294–305.

Mottram, J. C. 1933. Changes in the non-dividing nucleolus following gamma radiation. *J. micr. Soc.*, 53: 213–219.

Nadson, G., and E. Rochlin. 1933. L'effet des rayons X sur le protoplasme, le noyau, et le chondriome de la cellule végétale d'après les observations sur le vivant. *Protoplasma*, 20: 31–41.

Nürnberger, L. 1923. Histologische Untersuchungen über die Einwirkung der Röntgenstrahlen auf das Zellprotoplasma. *Virch. Arch. Pathol. Anat. Physiol.*, 246: 239–252.

Olivieri, F. 1929. Ricerche intorno all'azione dei raggi Röntgen sulla segmentazione dell'novo e sui processi morfogenetici elementari nel *Bufo vulgaris*. *Riv. Radiol. Fisica med.*, 1: 529–551.

Osgood, E. E. 1940. Effects of irradiation on leukemic cells in marrow cultures. *Proc. Soc. exper. Biol. Med.*, 45: 131–135.

——. 1942. Is the action of roentgen rays direct or indirect? *Amer. J. Roentgenol. Rad. Ther.*, 48: 214–220.

Packard, C. 1914. The effect of radium radiations on the fertilization of *Nereis*. *J. exp. Zool.*, 16: 85–129.

——. 1915. The effects of beta and gamma rays on protoplasm. *J. exp. Zool.*, 19: 323–353.

——. 1916. The effect of radium radiations on the rate of cell division. *J. exp. Zool.*, 21: 199–212.

——. 1918. The effect of radium radiations on the development of *Chaetopterus*. *Biol. Bull.*, 35: 50–70.

——. 1931. The biological effects of short radiations. *Quart. Rev. Biol.*, 6: 253–280.

——. 1945. Roentgen Radiations in Biological Research. *Radiology*, 45: 522–533.

Payne, F. 1913. A study of the effect of radium upon the eggs of *Ascaris megalocephala univalens*. *Arch. Entwmech. Org.*, 36: 287–293.

Petrova, J. 1940. Über den Einfluss der γ-Strahlen auf die Permeabilität der Zelle. *Beih. Bot. Cbl.*, A, 60: 343–387.

——. 1942. Über den Vergleich der α-Strahlen Empfindlichkeit von Kern und Plasma. *Ber. deutsch. bot. Ges.*, 60: 148–151.

Pietschmann, K. 1937. Über Bestrahlung von *Chlorella vulgaris* mit Röntgenstrahlen. *Arch. Mikrobiol.*, 8: 180–206.

Politzer, G. 1930. Über den Einfluss der Röntgenstrahlen auf die Regeneration der Linse. *Arch. Entwmech. Org.*, 121: 39–71.

Polzien, F. 1932. Theoretisches zur electiven Zellwirkung der Röntgenstrahlen. *Strahlentherapie*, 45: 189–196.

Provenzale, L. 1942. Ricerche sulla respirazione dei tessuti normali dopo irradiazione Roentgen. *Scr. ital. Radiobiol.*, 9: 147–156.

Puckett, W. O. 1934. The effects of X-radiation on limb development in *Amblystoma*. *Anat. Rec.*, 58: Suppl. 32.

——. 1936a. The effects of X-radiation on limb development and regeneration in *Amblystoma*. *J. Morph.*, 59: 173–213.

——. 1936b. The effects of x-radiation on the regeneration of the hydroid *Pennaria tiarella*. *Biol. Bull.*, 70: 392–399.

——. 1937. X-radiation and thyroid-induced metamorphosis in anuran larvae. *J. exp. Zool.*, 76: 303–323.

Ralston, J. H. 1939. The immediate and delayed action of X-rays upon the protozoan *Dunaliella salina*. *Amer. J. Cancer*, 37: 288–297.

Reiss, P. 1925. Sur l'action comparée des rayons X et du radium sur le noyau et le cytoplasme. *C.r. Soc. Biol. Paris*, 92: 1403–1406.

Richards, A. 1914. The effect of X-rays on the rate of cell division in the early cleavage of *Planorbis*. *Biol. Bull.*, 27: 67–96.

Rieder, H., and J. Rosenthal. 1922 .*Lehrbuch der* Röntgenkunde. Johann Ambrosius Barth, Leipzig.

Rose, S. M. 1944. Methods of initiating limbs regeneration in adult Anura. *J. exp. Zool.*, 95: 149–170.

Schaper,A. 1904. Experimentelle Untersuchungen über den Einfluss der Radiumstrahlen und Radiumemanation auf embryonale und regenerative Entwicklungsvorgänge. *Anat. Anz.*, 25: 298–314; 326–337.

Schechtmann, J., and V. Klüpfel. 1932. Beitrag zur Wirkung der Röntgenstrahlen auf die biologischen Gewebe. *Strahlentherapie*, 43: 792–795.

Scheremetjewa, E. A., (see: Sheremetieva, E. A.) and V. V. Brunst. 1933. Untersuchung des

Einflusses von Röntgenstrahlen auf die Regeneration des Schwanzes bei den Kaulquappen von *Pelobates fuscus*. *Arch. Entwmech. Org.*, 130: 771–792.

——, and ——. 1935. Untersuchung des Einflusses von Röntgenstrahlen auf die Regeneration der Extremitäten beim *Axolotl*. I. *Radiobiol. gener., Venezia*, 4: 57–77.

——, and ——. 1937. On the local destruction of the regenerative ability of the limb of Axolotls by X-radiation. *Trav. Inst. Zool. Biol. Acad. Sci. Ukraine, Kiev*, 17: 137–146.

——, and ——. 1938. Preservation of the regeneration capacity in the middle part of the limb of newt and its simultaneous loss in the distal and proximal parts of the same limb. *Bull. Biol. Med. exp., Moscow*, 6: 723–724.

SCHNEIDER, E. 1926. Worauf beruht die geringe biologische Wirkung der Röntgenstrahlen auf einzellige Lebewesen? *Klin. Wochenschr.*, Jg. 5: 97–99.

SCHOTTÉ, O. 1926. Systeme nerveux et régénération chez le *Triton*. *Rev. Suisse Zool.*, 33: 211.

——, and E. G. BUTLER. 1941. Morphological effects of denervation and amputation of limbs in Urodele larvae. *J. exp. Zool.*, 87: 279–322.

——, and M. HARLAND. 1943. Effect of denervation and amputation of hind limbs in Anuran tadpoles. *J. exp. Zool.*, 93: 453–487.

SCHREK, R. 1945. Radiosensitivity of lymphocytes and granulocytes in vitro. *Proc. Soc. exp. Biol. Med.*, 58: 285–286.

SCHWARZ, G. 1926. Über die Latenzzeit. *Acta Radiol.*, 7: 452.

SCOTT, C. M. 1934. Action of X-rays on the eggs of *Calliphora*. *Proc. roy. Soc. Lond.*, 115: 100–121.

SHEREMETIEVA, E. A. (see: Scheremetjewa, E. A.). 1937. On the problem of the effects of X-rays upon the development of Axolotls. *Trav. Inst. Zool. Biol. Acad. Sci. Ukraine, Kiev*, 17: 147–163.

SMITH, G. M. 1932. Melanophores induced by X-ray compared with those existing in patterns as seen in *Carassius auratus*. *Biol. Bull.*, 63: 484–491.

SNIDER, G., and H. KERSTEN. 1935. The action of soft X-rays on *Cladocera*. *Physiol. Zool.*, 8: 530–538.

——. 1936. Susceptibility to soft X-ray of *Daphnia magna* during its development from egg to young in the brood pouch. *J. exp. Zool.*, 74: 1–6.

SPARROW, A. H. 1944. X-ray sensitivity changes in meiotic chromosomes and the nucleic acid cycle *Proc. Natl. Acad. Sci. Wash.*, 30: 147–155.

SPEAR, F. G. 1932. The effect of spaced radiation on tissue cultures in vitro. *Proc. roy. Soc. London.* B, 110: 224–234.

——. 1946. The biological effects of penetrating radiation. A review. *Brit. med. Bull.*, 4: 2–10.

STONE, R. G. 1932. The effects of X-rays on regeneration in *Tubifex tubifex*. *J. Morph.*, 53: 398–431.

STOWELL, R. E. 1945. The effects of Roentgen radiation on the thymonucleic acid content of transplantable mammary carcinomas. *Cancer Res.*, 5: 169–178.

STRANGEWAYS, T. S. P., and H. B. FELL. 1927. A study of the direct and indirect action of X-rays upon the tissues of the embryonic fowl. *Proc. Roy. Soc. Lond.*, B, 102: 9–29.

——, and F. L. HOPWOOD. 1926. The effects of X-rays upon mitotic cell division in tissue cultures in vitro. *Proc. Roy. Soc. Lond.*, B, 100: 283–293.

TAYLOR, C., J. P. GREENSTEIN, and A. HOLLENDER. 1947. Effects of X-radiation on thymus nucleic acid. *Science*, 105: 263–264.

THOMAS, J. A., and M. CHEVREMONT. 1938. Le chlorure de trimethylethylammonium rend-il certaines cellules plus sensibles à l'action des rayons X, in vitro. *C.r. Soc. Biol. Paris*, 129: 1087–1090.

TOKIN, B., and G. GORBUNOWA. 1934. Untersuchungen über die Ontogenie der Zellen. *Biol. Zh.*, 3: 294–306. (Russian).

TORRIOLI, M., and S. FIORENTINI. 1935. Le cellule giganti nel midollo ossea di animali irradiati con raggi X. *Pathologica, Genova*, 27: 37–41.

TOUMANOFF, C. and S. VERETENNIKOFF. 1930. Résultats préliminaires d'expérience d'irradiation par les rayons X sur *Carasius morosus*. *Bull. Biol. France, Belg.*, 64: 495–510.

TSCHASSOWNIKOW, N. 1928. Ueber die Wirkung der Röntgenstrahlen auf den feinen Bau der Leberzellen beim Frosch. *Virch. Arch. Pathol. Anat. Physiol.*, 269: 166–177.

TSUZUKI, M. 1926. Experimental studies on the biological action of hard Roentgen rays. *Amer. J. Roentgenol. Rad. Ther.*, 16: 134–150.

TURNER, C. D. 1935. The effects of X-rays on anterior regeneration in *Lumbriculus incostans*. *J. exp. Zool.*, 71: 53–81.

UMANSKI, E. 1937. Untersuchung des Regenerationsvorgänges bei Amphibien. *Biol. Zh.*, 6: 739–756. (Russian).

VALETTE, M. 1929. Regeneration du museau et territoires de regeneration chez les Urodeles. *Bull. Biol.*, 63: 95–148.

VERNONI, G. 1911. Studi di embriologia sperimentale. *Arch. Entwmech. Org.*, 31: 307–334.

VINTEMBERGER, P. 1928. Sur les variations de la radiosensibilité au cours des premières mitoses de segmentation dans l'oeuf de *Rana fusca*. *C.r. Soc. Biol. Paris*, 98: 532–535.

WAIL, S. S., and S. R. FRAENKEL. 1926. The effect of radium rays on the protoplasm of a cell. *Ann. Roentgenol. Radiol.*, 2: 140–143.

——, and J. G. LIBERSOHN. 1926. Über die Wirkung

der Röntgenstrahlen auf die Protoplasmastruktur. *Zbl. allg. Pathol. pathol. Anat.*, 37: 247–250.

WARREN, S. 1936. The physiological effects of radiation upon organ and body systems. In *Biological Effects of Radiation* (B. M. Duggar, ed.), pp. 473–539. McGraw-Hill Book Co., New York & London.

WATTENWYL, H. 1941. Über die Wirkung der Röntgenstrahlen auf den Rattenhoden. *Verh. Schweiz. Naturforsch. Ges.*, 121: 203.

WEIGAND, K. 1930. Regeneration bei *Planarien* und *Clavelina* unter dem Einfluss von Radiumstrahlen. *Z. wiss. Zool.*, 136: 255–318.

WEISS, P. 1925. Unabhängigkeit der Extremitäteregeneration vom Skelett. *Arch. Entwmech. Org.*, 104: 359–394.

——. 1927. Die Herkunft der Haut im Extremitätenregenerat. *Arch. Entwmech. Org.*, 109: 584–610.

WHITING, A. R. 1940. Sensitivity to X-rays of different meiotic stages in unlaid eggs of *Habrobracon*. *J. exp. Zool.*, 83: 249–369.

WINKLER-JUNIUS, E., and B. J. VON DER PLATTS. 1929. The influence of X-rays on fertilized axolotl eggs of different ages. *Proc. roy. Acad. Amsterdam*, 32: 236–247.

WOTTGE, K. 1939. Forgesetzte Beobachtungen am bestrahlten Zellkern. *Naunyn-Schiedebergs Arch.*, 193: 96–106.

ZIMMERN, A., and J. A. CHAVANY. 1931. Die Radiosensibilität des Nervengeweges. *Strahlentherapie*, 41: 482–495.

SPECIATION IN ANCIENT LAKES

By JOHN LANGDON BROOKS

Osborn Zoological Laboratory, Yale University

INTRODUCTION

OUR knowledge of the geographical aspects of speciation is based primarily upon the distribution of species and subspecies of terrestrial animals, especially birds.

An observer on a broad continental area is accustomed to finding a single species occupying one particular ecological niche over that large area wherein the niche is available. Over some regions of the land surface the niches of a given kind are linearly arranged, as for instance in the narrow lowland strip between the mountains and the sea which makes up the greater part of the western coast of North America. In this geographical situation an observer is impressed by the fact that representatives of a species inhabiting the entire linear strip have a different appearance, depending upon which part or small section of the strip they live in.

The fox sparrows of North America illustrate the effect of the arrangement of habitats, in a way beautifully worked out by Swarth (1920). All the fox sparrows belong to a single species *Passerella iliaca*. Those of eastern North America breed over the entire forested area of Canada, and in Newfoundland and northern Alaska as well. Although differences can be noted between birds taken from the eastern and western ends of the range, they are minor and unworthy of nomenclatural recognition. All are considered to belong to the typical subspecies. Fox sparrows also find the west coast of North America habitable and breed from the proximal Aleutian Islands south to the Olympic Peninsula in Washington. Within this coastal strip there is considerable variation of the fox sparrows in coloration (from bright reddish-brown to clear gray), in relative lengths of feet and tail, and in size and shape of the bill. Six subspecies have been named from limited areas along this strip. However, there is complete intergradation between five of these subspecies, and those areas of transition from one subspecies to another within a short space are taken as the boundaries of adjacent subspecies. There do not appear to be any physical barriers within these regions of transition different from those within the range of any one subspecies. The fox sparrows which breed on Kodiak Island are different from either of the two subspecies on adjacent parts of the Alaskan Coast, from which they are, of course, isolated and constitute a separate subspecies *insularis*.

Aside from the northwestern corner of the state of Washington, which is inhabited by the southernmost members of this chain, the only zones habitable by fox sparrows in the western United States cover the upper slopes of mountains. These habitable areas become smaller and more isolated to the southward. The subspecies with the largest ranges are: *fulva*, which breeds throughout central Oregon and the northeastern corner of California; *mariposae*, whose breeding colonies are scattered throughout the north and central parts of the Sierra Nevada; and *schistacea*, which breeds in the Rockies from Alberta to Nevada and eastward into eastern Wyoming. The subspecies with more limited ranges occur to the south and the west of these wider-ranging subspecies: *brevicauda* breeds in a restricted area in the Coast Range in north central California; and *monoensis* and *canescens* are each confined to limited areas on the eastern slopes of the Sierra Nevada, in the central part of California near the Nevada border. The population of each of these two areas has diverged just enough to be recognized taxonomically, whereas the population of fox sparrows in several isolated mountain areas exhibit insufficient morphological distinctions and are grouped in the subspecies *stephensi*. References to the latter two types of habitat distribution, viz., the linear arrangement and the highly isolated types, are readily available in ornithological literature. Mayr (1942) has quoted several. One example to which I wish to direct at-

tention is that of the lowland birds of New Guinea, whose habitat is the narrow strip encircling the central mountains. If Lake Baikal is conceived as being essentially similar to a water-filled cast of New Guinea, then the similarity of the horizontal and vertical zonation of the lake's benthic fauna to that of the island's fauna is not surprising (cf. p. 53).

The birds of archipelagos are classic examples of the second type of distribution, in which the habitats are widely separated. It is important that the essential features of distribution of the closely related species of an archipelago, such as the drepanids of the Hawaiian Islands, be borne in mind. The first feature is that obviously related populations on different islands may either be morphologically similar or may exhibit differences compatible with the assignment of subspecific or specific names, but usually they occupy the same or similar ecological niches. This is to be expected from observations of isolated habitats or clusters of habitats in continental areas. The group of lakes of the isolated Malili River of central Celebes is to the animals inhabiting the lakes what the islands are to the birds of an archipelago. The distribution patterns are entirely analogous.

The more striking feature of the Hawaiian drepanids is the fact that populations similar in general structure, nesting habits, and songs nevertheless exhibit profound differences in bill structure and feeding habits (Perkins, 1903). Trophic specialization in this one group of closely related birds has resulted in an array of bill structures which cannot be matched in any other family, or even in several taken together. Only among the closely related species of old lakes can comparable phenomena be found. Three lacustrine species flocks possibly exceed the drepanids in degree of trophic specialization. These are the cichlid flocks of the African lakes, Nyasa, Tanganyika, and Victoria. The most astonishing of these is the *Haplochromis* flock of Nyasa, with over one hundred species, most of which are only distinguishable on the basis of their mouth structure and pharyngeal teeth (Trewavas, 1935). The acme of trophic specialization is attained by the two Nyasan cichlid species of *Corematodus* whose diet consists solely of the small scales on the tails of certain other species of the same *Haplochromis* species flock (see Part II, section on Distribution and Speciation in Nyasa). The diversity of feeding habits associated with these structural differences has led some investigators to believe that a special kind of ecological speciation must have been involved.

It is the purpose of this paper to indicate that there is evidence that the principles of speciation derived from the study of terrestrial animals apply to the faunas of ancient lakes as well. The cichlid flocks in the African lakes are an extreme but comprehensible result of isolation and subsequent competition between closely related aquatic species, just as the drepanids are among birds (see Amadon, 1947). Although the general features of the evolution of lacustrine species flocks are apparently discernible, a tremendous amount of detailed information is necessary to test the validity of the hypotheses advanced and to serve as the basis for a more complete understanding of these spectacular evolutionary phenomena.

LAKE BAIKAL

The Baikal of today

Baikal is a long narrow lake lying with a northeast-southwest trend between 51° 43′ and 55° 46′N and 103° 44′ and 109° 37′E (Fig. 1). The long axis of the lake, which appears slightly curved on the map with its concavity towards the northwest, measures 674 kilometers. Its width varies between 25 and 74 km. (Fickeler, 1927). The lake occupies the bottom of a tectonic trough between nearly parallel mountain ranges which rise steeply from the lake shore except at the delta of the Selenga River. The area of the lake is 33,000 sq. km., and the area of the watershed is twenty times as large (Halbfass, 1928). This drainage is carried principally by three rivers, the Upper Angara, the Bargusin, and the Selenga. The Upper Angara runs NE from the northern end of the lake, draining the extension of the trough within which the lake lies. The Bargusin River empties into the middle of the east coast after draining a trough which parallels the northern half of the lake. The Selenga River, by far the largest of the lake's tributaries, drains the complex series of tectonic troughs and mountain ranges to the south and southwest of Baikal, emptying into the lake on the east shore about one-third of the way up from the southern end. The lower Angara, the lake's sole effluent, breaches the otherwise uninterrupted wall of mountains forming the west wall of the trough near the southern end of the lake and runs NW, joining the Yenesei River, which empties into the Arctic Ocean.

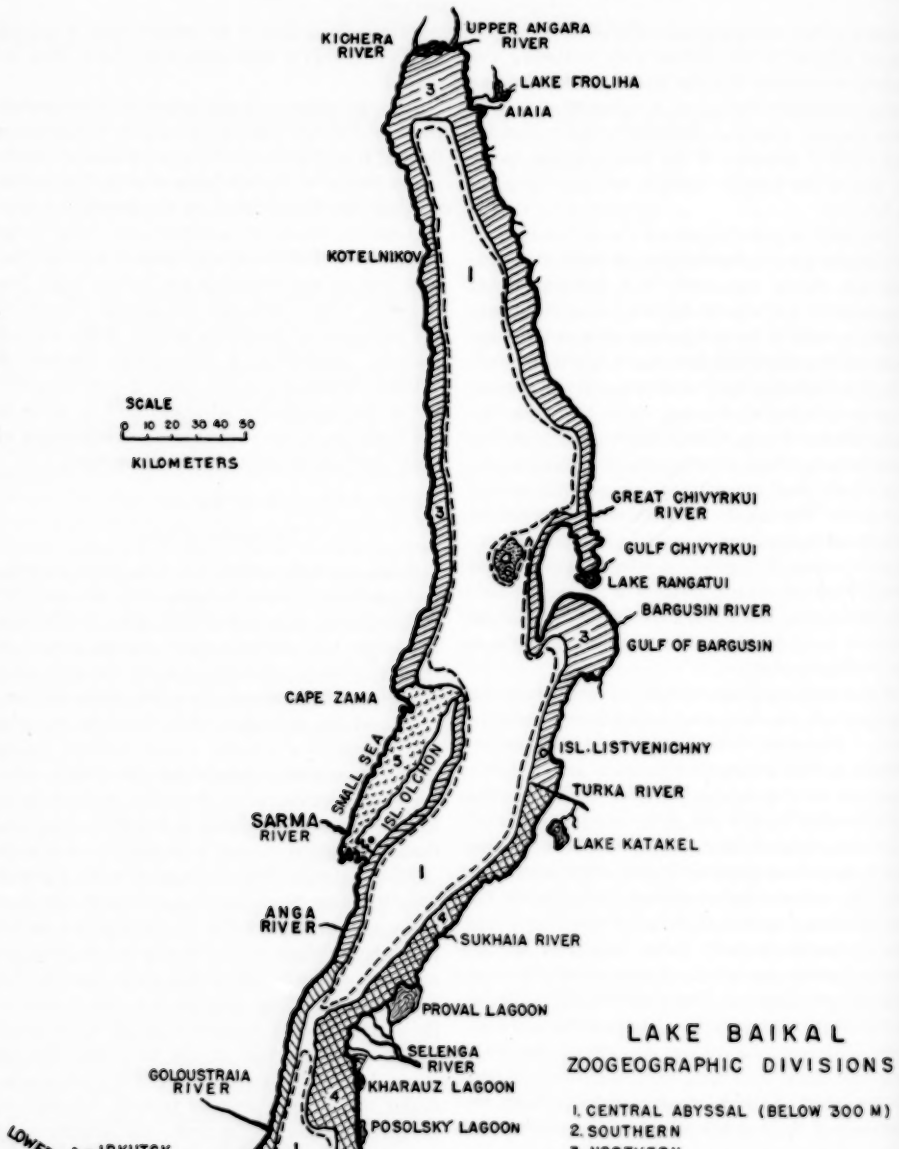


FIG. 1. ZOOGEOGRAPHIC DIVISIONS OF LAKE BAIKAL
(Based upon map in Dorogostaisky 1923, with 550 m. contour added from bathymetric map in Drizenko, 1908.)

The principal irregularities in the present coastline of Baikal are restricted to the central section of the lake. On the west the 75 km. long island of Olchon, separated at its southern end from the mainland by the narrow Strait of Olchon, forms the east bank of a long channel called the Small Sea. The peninsula Swajatoi-Noss, or Holy Nose, on the east shore encloses with its southern projection Bargusin Gulf, and with its northern, Chivyrkui Gulf. The Ushanii Islands lie just off the northern part of the Holy Nose. The only other major irregularity of the coastline is the Bay of Proval, adjacent to the Selenga delta on the northeast. This narrow stretch of water was formed by a sudden submergence of the land, toward the end of the last century.

Our knowledge of the bathymetry of Lake Baikal is based primarily upon the results of the Russian Hydrographic Expedition of 1896–1902. The surface is 462 m. above sea level. Three bathymetric regions are distinguishable. The southern basin, reaching a depth of at least 1441 meters, is separated from the middle basin by a ridge in the region of the Selenga delta. Vereščagin (reported by Halbfass, 1937) found a depth of 1741 m. in the middle basin, just off Olchon Island, proving Baikal the deepest lake in the world. North of the Ushkanii Islands the bottom is close to 800 meters deep throughout (Drizhenko's (1908) map, as reproduced by Fickeler, 1927).

A brief consideration (based largely on Fickeler) of the physics and chemistry of the lake water is necessary as a background to a study of the biota. The individual and total concentrations of various ions are within the ranges found in lakes of regions of external drainage. The distribution of temperature and oxygen in Baikal, the deepest lake in the world, is of greater importance. The temperature of the water below 250 m. is always between 4°–3.2°C., decreasing as the depth, and hence the pressure, increases. Twice a year, in late June and early December, the waters above 250 m. are also at 4°C. These are the periods of circulation, for the wind can mix the water to great depths when the density at all depths is very nearly the same. The waters above 250 m. are warmer than 4°C. from June until December, but at their maximum near the end of August the surface layers of the open water only reach 10°–15°C. Indeed, it is only the upper 5–10 m. which attain these temperatures. Below this superficial layer the amount of summertime warming is slight and decreases with depth. However, the surface temperatures in Chivykui and Bargusin Gulfs and the Small Sea may be as high as 20°C. in August, according to Dorogostaisky (1922). The waters all are well oxygenated to the greatest depth, so that the entire bottom is available for exploitation by aerobic organisms. At 1600 m. there was 6.77 cc./l. O_2 or 70% saturation at that temperature (Vereščagin, 1927, 1936).

In order for these deep waters to contain that much oxygen in the face of the continual, if slow, biological removal, they must be mixed with water which has been at the surface at times of circulation. Vereščagin (1936), as reported by Strøm (1945), is of the opinion that surface water can be fully circulated to a depth of 400–600 m. He further stated that partial circulation to 1000 m. is possible, but that the waters below this level are stagnant. However, it is impossible to see how water at 1600 m. can contain the amount of dissolved oxygen that it does, if the partial circulation does not extend to that depth.

Geological history of the Baikal basin

The most recent stratigraphic studies (Presniakov, 1940) indicate that all parts of the present basin were not formed at the same time. The southern basin is of Paleocene origin, at the youngest, and may have been in existence as far back as the end of the Cretaceous. This makes the maximum age of the lake between 50 and 75 million years (cf. Zeuner, 1946). The formation, or at least the deepening, of the rest of the present basin is associated with the crustal movements of the Pleistocene. The frequent earthquakes attest to crustal instability at the present time. Martinson (1940) has reported the results of his study of the microfossils of various lacustrine deposits encountered in the region adjacent to the eastern and southeastern coasts of the lake. Some of these beds had been exposed by erosion; others were sampled by deep borings. Analysis of the microfossils of these deposits has indicated that during the entire Tertiary, and possibly even earlier, the land adjacent to the south and middle basins was forested, indicating a relatively moist clinate. There is evidence of two types of freshwater basins within this forested area. One type was the shallow, often marshy lake whose fauna and flora were representative of that wide spread in the freshwater of Circumbaikalia. The other was the basin, or series of basins, populated by forms belonging to the ancient stocks which characterize the biota of present day Baikal. As we shall see later, the small lakes and ponds now found on the shores of Baikal contain common

Siberian species, and, with a single exception, none of the species that are peculiar to Baikal.

During the intervening Pleistocene, the Baikal Mountains flanking the lake on the west and the Vitim Plateau which rises above the northern third of the east shore developed glaciers. The southeast half of the Baikalian coast line was not approached by any glaciation, except for a tongue that reached from the Sayan Mountains toward the southern basin (Flint and Dorsey, 1945). Although the lake was apparently not covered by glacial ice, the lower temperatures undoubtedly had a profound effect upon its biota. Martinson (1940) found that many species of marine and brackish water affinities which had lived in the lake during the earlier part of the Cenozoic are now extinct.

It might be well to summarize a few facts which the reader should bear in mind while reading the following section on speciation. The south basin of the present Lake Baikal has held water continuously since the early Cenozoic or end of the Cretaceous. The trough in which the lake lies has been the site of considerable crustal movement, so that the lake has undoubtedly passed through a long and complex series of configurations. The lake in its present form is probably deeper than it has ever been before. The water down to the greatest depth sampled is well oxygenated, so that under present conditions aerobic organisms are not excluded from any part of the lake by a lack of oxygen. The effect of Pleistocene glaciation on the distribution of life in the lake is unknown. The relevance of the rest of the material presented should become apparent during the discussion of speciation.

COMPOSITION OF THE BAIKALIAN FAUNA

A scrutiny of Table 1, which summarizes our knowledge of the fauna of Lake Baikal, will reveal several unique aspects. Immediately apparent is the high degree of endemism and the small number of groups dominated by non-endemic species. The protozoa, rotifers, and diatoms (the latter group having 310 endemic and 369 non-endemic species), the three chief groups represented primarily by non-endemic species, have many species which are widely distributed throughout the freshwaters of the world, and are characterized by the ease with which they are passively dispersed. The non-endemic fish all belong to species with wide distributions, and undoubtedly have actively invaded Baikal within relatively recent times, bringing parasites with them.

The absence from the faunal list of many freshwater animals will be readily noted by anyone familiar with the biological communities of lakes. There are no amphibious vertebrates, and the Trichoptera are the only amphibious insects. Although no rhizopods, hydrarachnids, or cladocerans are recorded from Baikal proper, species of these and of chironomids, all typical of that part of the Palaearctic, are abundant in the small lakes which empty into Baikal, and in the ponds and

TABLE 1

Endemism of the Baikalian Fauna

(Based on Table 1 of Vereščagin, 1940)

GROUP	TOTAL NO. ENDEMIC FORMS	TOTAL NO. NON-ENDEMIC FORMS	PER CENT OF ENDEMISM
Protozoa	80	130	38%
Porifera	6	1	86%
Coelenterata	0	1	0%
Platyhelminthes	(89)	(7)	93%
Turbellaria	(86)	(0)	100%
Rhabdocoela	7	0	100%
Alloeocoela	1	0	100%
Triclada	78	0	100%
Trematoda	3	3	50%
Cestoda	0	4	0%
Nematodes (?)*	3	2	60%
Annelida	(59)	(4)	94%
Polychaeta	1	0	100%
Oligochaeta	53	4	93%
Hirudinea	5	0	100%
Rotifera	6	17	26%
Bryozoa	1	0	100%
Arthropoda	(377)	(7)	98%
Crustacea	(370)	(7)	98%
Copepoda	(38)	(7)	84%
Calanoida	0	2	0%
Harpacticoida	37	0	100%
Parasitic	1	5	16%
Ostracoda	36	0	100%
Isopoda	5	0	100%
Amiphipoda	291	0	100%
Insecta			
Tricoptera	7	0	100%
Mollusca	(98)	(1)	99%
Gastropoda	91	1	99%
Pelecypoda	7	0	100%
Vertebrata	(30)	(7)	81%
Fish	29	7	81%
Mammalia	1	0	100%

* The nematodes are queried because their number is astonishingly low.

swamps associated with the deltas of the larger rivers.

The following section deals in more detail with some elements of the fauna which contribute most to our knowledge of the origin of the biota and its evolution.

Porifera

The sponge fauna is remarkable for the presence of the Lubomirskiidae, comprising the genera *Baicalospongia* Annandale, *Lubomirskia* W. Dybowski, *Baikalolepis* Makushok (1927), and *Swartschewia* Makushok. The only representatives of this family known outside of Lake Baikal is *Baicalospongia dzhegetajensis*, which Rezvoj (1927) described from Dzegetaj-Kul in the Uriankhai region (Tanna Tuva) to the west of the southern end of Baikal. Little is known about this small lake. Martinson (1940) found spicules in the deposits of an ancient Lake Baikal which are similar to those of the extra-Baikalian species. The primitive nature of *B. dzhegetajensis* is also indicated by its resemblance to *Lubomirskia*. Martinson (1940) considers that the Lubomirskiidae, together with the Caspian sponges of the genus *Metschnikovia* Grimm (family Gellidae) and the genus *Ochridospongia* Arndt of Lake Ochrid, represent a stock which split off from its marine ancestors (Renieridae?) independently of the widespread freshwater Spongillidae. This conclusion is apparently confirmed by the findings of Taliev (1940), whose serological studies indicate that *Baikalospongia* is more closely related to a Caspian sponge than to the Spongillidae.

There are also spongillids of the genera *Spongilla*, *Carterias*, and *Ephydatia* in Baikal.

Turbellaria

Although Vereščagin lists 86 species of Turbellaria from Baikal, this number should be considered only an approximation, since 78 of these are triclads described in a superficial, highly unsatisfactory way by Korotneff in 1912.

Over half of Korotneff's species are assigned to the genus *Sorocelis*, which had been established by Grube in 1872 for a many-eyed triclad from Baikal and given the specific name *nigrofasciata*. Subsequently numerous species of many-eyed triclads from Baikal, and the rest of Asia as well, were assigned to this genus, largely because it had never been properly defined. In 1930 Kenk limited the genus to many-eyed species of the family Dendrocoelidae, and assigned multiple-eyed Planaridae to *Polycelis* Ehrenberg 1831. Kenk lists the genus *Seidlia*, which Sabussow proposed in his 1911 paper on Baikalian triclads, as a synonym of *Polycelis* Ehrenberg, so that there are species of both *Sorocelis* and *Polycelis* in Baikal. Kenk found it impossible to assign the 38 species which Korotneff ascribed to *Sorocelis* to either genus, because their anatomy is unknown. Even the 19 species which Sabussow, usually a careful worker, called *Sorocelis* in 1911 cannot be properly placed, as he failed to describe the critical anatomical features. The status of each of the 25 species of *Planaria* which Korotneff claims from Baikal is dubious for similar reasons.

In addition to these there are about a dozen species of triclads in Baikal which are remarkable in their possession of one to many suckers. Korotneff classified these in six genera, four of his own creation, and believed that they constituted an endemic family. Until more is known of the anatomy of these animals, their position in relation to other Probursalia cannot be determined. Several names have been given to this family. Korotneff first called it Cotylifera in 1908, but in 1912 substituted Cotylidae. However, this is invalid, as it is not named after a genus in the family, and Van Graff while monographing the Turbellaria proposed the name Procotylidae after *Procotylus* Korotneff 1912. To add to the confusion, Vereščagin (1940) called the family Rimacephalidae. This name is based on *Rimacephalus*, which Korotneff introduced in 1901, on the ground that its previous name was occupied, for a species that Grube in 1872 had named *Dicotylus pulvinar*. But this substitution is unwarranted because, as Berg (1928) pointed out, the prior name cited is really *Dicotyles* Cuvier, and not *Dicotylus*. Therefore, neither *Rimacephalus* nor Rimacephalidae is valid, and Procotylidae Van Graff is the correct name for this ill-defined group of sucker-bearing Baikalian triclads.

The genus *Sorocelis*, the only well-defined one to which any of the Baikal triclads can be assigned, is primarily an Asiatic genus, although it has been found in New Guinea and North America (Hyman, 1939). The American form is known to occur only in the ancient Ozark Mountains, living in caves and in springs associated with caves.

The single Baikalian representative of the Alloeocoela, *Baikalarctia gula* Friedmann 1926, reaches a length of 40 mm. and is about one-half as wide. This species is sufficiently distinct to be

separated into its own family, the Baikalarctiidae (Bresslau, 1933).

Six of the rhabdocoels belong to *Baikalellia*, a genus erected by Nasonov in 1930 for these and two extra-Baikalian species. This genus is placed in the family Graffillidae. The species in Lake Baikal are associated with littoral vegetation, having never been taken below 30 m. They undoubtedly constitute a species flock. The position of the seventh Baikalian rhabdocoel has not been settled. Although Rubtzoff assigned it to the polycystid genus *Acrorhynchus*, Nasonov (1930b) indicates that from the published description it cannot be assigned to any genus of Polycystidae. Settlement of its position awaits a more complete description.

Annelida

A sabellid polychaete *Manajunkia baicalensis* (Nusbaum) lives in Lake Baikal (Fig. 3, *13*). Species of this genus have been found in widely separated points in Eurasia and North America, inhabiting fresh and brackish waters as well as the littoral zone of the sea.

Roughly half of the endemic oligochaetes are distributed among twelve genera of the family Lumbriculidae. *Lamprodrilus* Michaelson, probably the most primitive genus of the family, has sixteen species. Eleven are known only from Baikal. Two other Baikalian species have also been found in old European lakes. *L. pygmaeus* occurs outside of Baikal in Lake Ochrid in Macedona, and *L. isoporus* in Lakes Ladoga and Onega in Russia. Three species of *Lamprodrilus* do not occur in Baikal. *L. tolli* has been found in northern Siberia and on the New Siberian Islands, *L. michaelsoni* is a Balkan form, and the third species, *L. mrazeki*, has been discovered in Bohemia (Svetlov, 1936). One of the smaller endemic genera, *Agriodrilus*, deserves mention. This monotypic genus differs from all other oligochaetes in the excessive development of mesenchymatous tissue, which restricts the coelom in the anterior and middle regions of the body. Michaelson (1926) is of the opinion that *Agriodrilus* illustrates the way in which the leech morphology developed from that characteristic of oligochaetes.

Mollusca

About 90 species of molluscs have been described from Lake Baikal, all but 15 of which are snails, both prosobranchiate and pulmonate. One pulmonate genus *Physa* has a single Baikalian species, while *Limnaea*, *Planorbis*, and *Ancylus* have 2, 5, and 5 species, respectively. One non-endemic prosobranchiate genus *Valvata* has 7 Baikalian species, and another, *Bulimus*, is uniquely represented.

Choanomphalus, with 15 species, is the only endemic pulmonate genus (Fig. 2, *12*, *13*), while there are four prosobranchiate genera, *Benedictia*, *Kobeltocochlea*, *Baicalia*, and *Liobaicalia*. The architecture of the shells of *Benedictia* and *Kobeltocochlea* is very similar, but they can be concisely differentiated on the basis of the radular structure (Fig. 2, *1–4*). The lateral and marginal plates of *Benedictia* are without teeth while those of *Kobeltocochlea* are toothed. Furthermore, the middle plate in *Kobeltocochlea* has a mesocone which is never found in *Benedictia*. Lindholm (1926) has separated the three species of the latter genus into three subgenera, employing the differences in the middle plates. Lindholm considered *B. fragilis* (the most typical species) most primitive because of the lack of marginal teeth on the middle plates. The degree of development of the toothed margins differentiates the subgenera *Dalainoria* and *Baicalocochlea*. The radula of *Kobeltocochlea* with its strongly-toothed margins is regarded as the terminal member of this evolutionary series. Lindholm, who was the foremost recent student of the Baikalian molluscs, stated (1926) that the species in these two genera exhibit no affinity with any other living snails and must be considered to constitute the family Benedictiidae. Rammelmeyer (1940) assigned a Cretaceous snail *andreae* from the Vitim region to the east of Baikal, which he had originally described as *Paludina*, to *Benedictia*. If he is correct, this agrees with Lindholm's interpretation that *Benedictia* is the more primitive. Until 1929 the Benedictiidae was considered to be restricted to Lake Baikal. In that year Lindholm received for identification five dried-up snails from Lake Kosogol, which lies 230 km. west of the southern end of Lake Baikal. As these were the first snails from Kosogol to come before the eyes of a biologist, they were of considerable interest. Four proved to be of a local race of the widely distributed *Limnaea* (*Radix*) *auricularia*, but the fifth was clearly a benedictiid. Although generic determination of such a poorly preserved specimen was difficult, Lindholm concluded that it represented a new species, *Kobeltocochlea michnoi*. How this snail came to be in Kosogol is not clear. Kosogol drains into one of the westernmost tributaries

of the Selenga River, and it might have penetrated from Lake Baikal into the Selenga and thence upstream about 1000 km. into Kosogol. One species of fish, *Thymallus arcticus baicalensis*, is common to the two lakes. This may also have entered through the Selenga. As yet the fauna of this river is completely unknown.

The 32 species of *Baicalia* make it by far the largest of the endemic genera. Unlike *Benedictia*, these species have radulae of little taxonomic importance, whereas a satisfactory classification has been based on the structure of the shell. Lindholm recognized 11 subgenera. Representatives of six of these are depicted in Fig. 2, *5–10*, by photographs taken from the beautiful lithographs which accompanied Dybowski's 1875 paper on the gastropods of Lake Baikal. The nomenclature is based upon that given by Lindholm (1924). A species with an evolute shell has been placed in the monotypic genus *Liobaicalia* (Fig. 2, *11*), but it is clearly a member of the *Baicalia* species flock.

Cretaceous shells from Transbaikalia, i.e., the region to the east of the lake, have been assigned by Rammelmeyer (1940) to *Baicalia*. One very badly preserved shell was compared with *B. ciliata*; another resembled *B. florii*. Several shells previously described by Reiss as *Cerithium gerassimori* were placed by Rammelmeyer in *Baicalia*.

The exceedingly fine dentition on the radulae of *Baicalia* is unlike that of any of the families to which *Baicalia* appears similar on the basis of conchological characters: Melaniidae (tropical Asia), Micromelaniidae (Caspian Sea), Pleuroceridae (American), Hydrobiidae (=Amnicolidae=Paludestrinidae). Lindholm (1926) concluded that *Baicalia* and *Liobaicalia* cannot be assigned to any prosobranch family and must be considered to constitute the family Baicaliidae. Some malacologists have assigned these four prosobranchiate genera to that large family variously called Hydrobiidae, Ammicolidae, Paludestrinidae. (In 1924 Annandale pointed out that this family of freshwater and estuarine snails cannot be clearly separated from the marine Rissoidae on either morphological or ecological grounds.) Thiele (1928), in a revision of the taxonomy of this assemblage of freshwater snails, further subdivided them into the families Hydrobiidae and Micromelaniidae. He classified *Benedictia* and *Kobeltocochlea* as a tribe Benedictieae of the typical subfamily of Hydrobiidae, disagreeing with Lindholm's conclusion that the radulae in these two genera are widely different from those of certain hybrobiids. Furthermore, he believed that *Benedictia* is the more divergent genus, as *Kobeltocochlea* shows the strongest resemblance to other hydrobiids. *Baicalia* and *Liobaicalia* are placed in the typical subfamily of the Micromelaniidae, because of the great similarity of shell and dentition. Thiele does not cite Lindholm's (1926) views.

The pelecypod genera *Sphaerium* and *Pisidium* have five and nine Baikalian species, respectively.

Crustacea, Isopoda

All of the isopods of Lake Baikal belong to the genus *Asellus*. Birstein's recent study (1939) has confirmed the presence of five species. Four clearly belong to the subgenus *Baikaloasellus*, which Stammer erected in 1932 for the only two Baikalian species well characterized at the time. The fifth species, *A. dybowskii* Semenkewitsch, provisionally placed by Stammer in *Baikaloasellus*, is separated by Birstein into a new subgenus *Mesoasellus*, together with cave-dwelling species from Japan and California. *Mesoasellus* and *Asellus* sensu strictu resemble each other in the possession of several primitive morphological features. *Baikaloasellus* is closer to *Mesoasellus* than it is to any of the other three subgenera. Birstein believes that the species of *Baikaloasellus* arose in the lake from a representative of *Mesoasellus*.

Crustacea, Amphipoda

The amphipods are the most remarkable element of the Baikalian fauna, for there are 291 species assigned to 30 genera. Some of the structural diversity to be found among these gammarids is shown in Fig. 3. Only one species is non-endemic, and only three of the genera have extra-Baikalian representatives. Presentation of a possible mechanism by which this large number of species could have arisen comprises one of the main theses of this paper.

An equally fascinating aspect of the problem presented by this group is the determination of its affinities. In 1928 three genera (*Axelboeckia*, *Carinogammarus*, *Echinogammarus*) were considered to be non-endemic in addition to the three now known to be so. Stebbing in 1906 grouped a Caspian amphipod with two Baikalian species into a genus *Axelboeckia*. Schellenberg (1940) believed the two groups unrelated and created *Boeckaxelia* for the Baikalian forms, since the type of *Axelboeckia* lives in the Caspian Sea. Schellenberg (1937) indicated

that the extra-Baikalian amphipods classified as *Carinogammarus* had been incorrectly assigned. The genus is endemic to Baikal. In the same paper he presented evidence that the non-Baikalian species of *Echinogammarus* are unrelated to the Baikalian forms assigned to this genus. As the type species does not occur in Baikal, the use of this generic name for species in the lake is erroneous. However, as no satisfactory name has been proposed, this genus will be referred to as "*Echinogammarus*" in this paper.

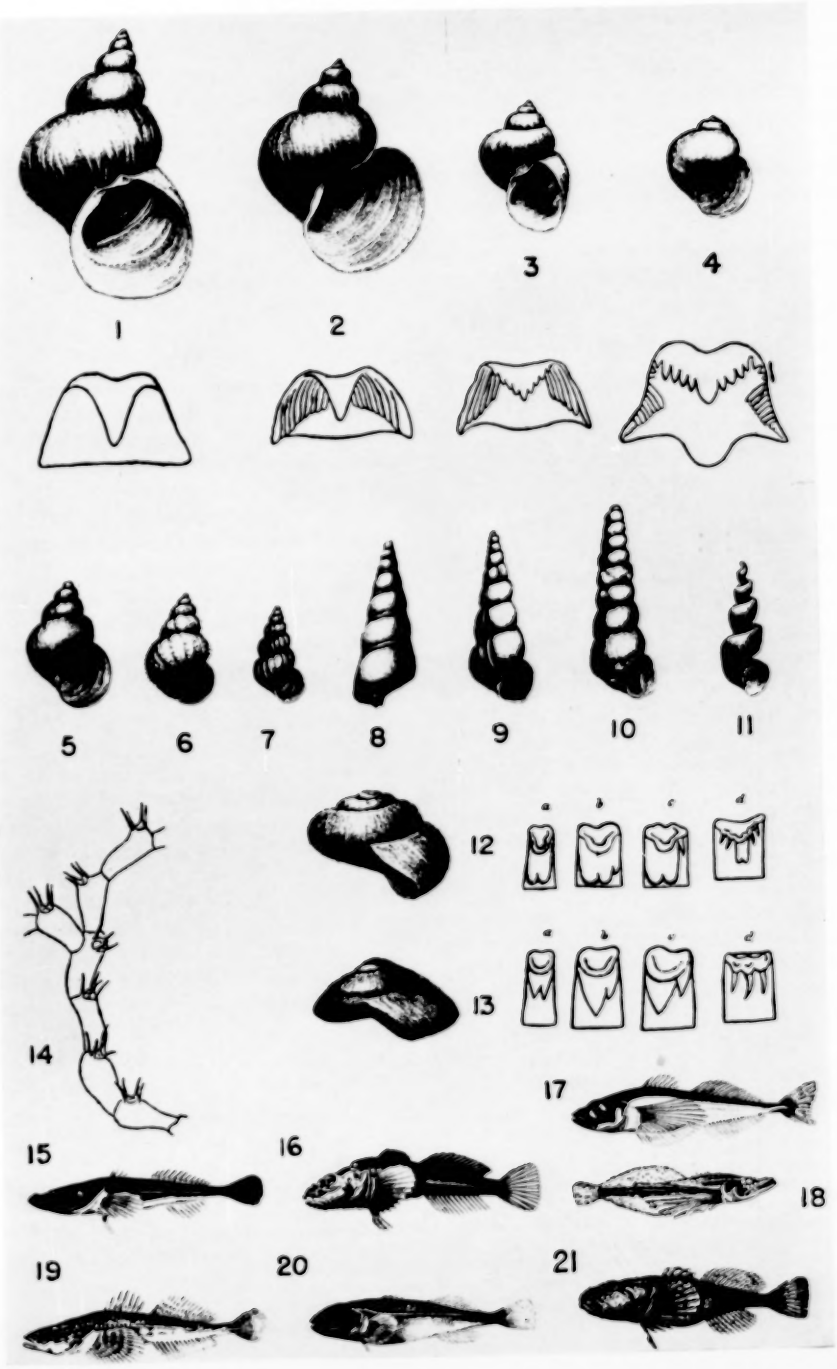
The three apparently authentic non-endemic genera (*Gammaracanthus*, *Pallasea*, and *Brandtia*) differ widely in their distribution. *Gammaracanthus loricatus* occurs in its typical form along the shores of the Arctic Ocean. A subspecies *lacustris* has been found in many lakes of the Baltic region of Europe and in at least one of the Siberian rivers draining into the Arctic Ocean, the Yenesei (Pirozhnikov, 1931). The Baikalian population is accorded subspecific rank as *G. l. baicalensis*. A Caspian counterpart is *G. l. caspica*. *Pallasea*, unlike *Gammaracanthus*, has many (at least 12) endemic species in Lake Baikal. *Pallasea quadrispinosus* occurs in the Baltic region, and in a small lake, Nalimje, on the western border of the Yenesei watershed (Pirozhnikov, 1933). Neither this species nor *P. laevis*, known from the freshwaters of Novaya Zemblya, occurs in Lake Baikal. Although the amphipod fauna at the mouths of the large rivers emptying into the Arctic Ocean has been extensively studied, neither these nor any other species of *Pallasea* have been found (Berg, 1935). There is no evidence that this species is of marine origin. *Brandtia* has an extra-Baikalian distribution quite different from that of either of the preceding two genera. At least three species of *Brandtia* have been described which are restricted to Lake Baikal. In addition, *Brandtia fasciata* is not only a common littoral form in the lake but also occurs in the small ponds draining into Baikal and throughout the Yenesei System, (Gurjanova, 1929), even in Nalimje Lake (Pirozhnikov, 1933). In the Yenesei delta the *Brandtia* population was sufficiently different from *B. fasciata* to be specifically distinguished as *B. fasciatoides* Gurj. As *Brandtia* has not been found outside of the Yenesei System, it is probable that this genus arose in Baikal and spread to other parts of the drainage system.

On the basis of this evidence, *Pallasea* appears to be the only one of the non-endemic genera which might represent one of the ancient amphipod stocks from which the multiplicity of Baikalian species arose. However, *Pallasea* shows less serological affinity with any of the 12 large endemic Baikalian genera than it does with *Pallasea quadrispinosa* from Lake Ladoga. This makes it rather unlikely that *Pallasea* is a relatively unmodified descendent of a stock from which any endemic genera have differentiated.

As the non-endemic genera do not appear to represent any of the original amphipod stocks, more tenuous evidence of the affinities of the endemic genera must be considered. Bazikalova

FIG. 2. REPRESENTATIVES OF THE BAIKALIAN FAUNA, PART 1

1–4, Shell and median radular plate (much enlarged), of
1, *Benedictia* (*Benedictia*) *fragilis* Dyb., shell height 49 mm.,
2, *Benedictia* (*Dalainoria*) *limaeoides* (Schrenck), height 38 mm.,
3, *Benedictia* (*Baicalocochlea*) *baicalensis* (Gerst.), height 23 mm.,
4, *Kobeltocochlea martensiana* (Dyb.), height 18 mm.
5, *Baicalia* (*Eubaicalia*) *angarensis* Gerst., height 7.5 mm.
6, *Baicalia* (*Dybowskiola*) *ciliata* Dyb., height 11 mm.
7, *Baicalia* (*Maackia*) *costata* Dyb., height 7 mm.
8, *Baicalia* (*Baicalia*) *carinata* Dyb., height 16.5 mm.
9, *Baicalia* (*Godlewskia*) *turriformis* Dyb., height 16 mm.
10, *Baicalia* (*Gerstfeldtia*) *Godlewskii* Dyb., height 19 mm.
11, *Liobaicalia stiedae* (Dyb.), height 9 mm.
12–13, Shell and radular plates (much enlarged), a = median plate, etc., of
12, *Choanomphalus maacki* Gerst., shell width 6 mm.,
13, *Choanomphalus valvatoides* Dyb., shell width 3 mm.
14, *Hislopia placoides* (Kor.) Branch of a colony. (enlarged ca. 10×)
15, *Limnocottus godlewskii* (Dyb.) length 190 mm.
16, *Limnocottus megalops* (Gratz.) length 160 mm. (male)
17, *Cottocomephorus grewingki* (Dyb.) length 175 mm. (female)
18, *Comephorus baicalensis* (Pallas) length 190 mm. (male)
19, *Batrachocottus multiradiatus* Berg length 150 mm.
20, *Batrachocottus nikolskii* (Berg) length 200 mm. (male)
21, *Batrachocottus baicalensis* (Dyb.) length 190 mm. (male)
(1–13 from Dybowski, 1875; 14 from Abricossoff, 1924; 15–21 from Berg, 1916. Retouched.)


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21

(1940) is of the opinion that the resemblances between four endemic Baikalian genera (*Brandtia*, *Hyallelopsis*, *Crypturopus*, and *Micruropus*) and four endemic Caspian genera are not the result of convergent modifications to meet similar ecological requirements but indicate genetic affinity. If this interpretation is correct, there were at least four original stocks in the primordial Baikal. Taliev's (1940) serological examinations were not designed to test this conclusion, although they gave no indication of close affinity with any Caspian genera.

The number of original amphipod stocks in Baikal undoubtedly falls between 4 and 29. Certainly the larger figure, the total number of genera at the present time, is too high. Six genera are monotypic and probably represent divergent members of larger stocks. For example, *Cammaracanthus insularis* is almost certainly derived from the *Hyallelopsis* stock (Bazikalova, 1935). Furthermore, serological comparisons indicate that several of the large genera may have a common origin. In Taliev's tests, representatives of *Pallasea*, "*Echinogammarus*," and *Acanthogammarus*, three of the largest genera, were compared to each other and to *Brandtia*, *Crypturopus*, *Boeckaxelia*, *Carinurus*, *Parapallasea*, *Abyssogammarus*, *Carjajewia*, *Brachyuropus*, *Spinacanthus*, and *Odontogammarus*. *Pallasea* gave no positive reaction with any of these genera. "*Echinogammarus*" gave a strong positive reaction with *Abyssogammarus*, somewhat less but still strong with *Odontogammarus*. *Acanthogammarus* had a strong serological affinity with *Brachyuropus*, slightly less with *Boeckaxelia*, *Carinurus*, and *Spinacanthus*. Assuming that each of these groups have evolved from a single stock, the maximum number of original populations now required is 18. It is of interest that not one of the four genera which Bazikalova considered little modified from the ancestral stocks showed any unequivocal serological affinity with other endemic genera.

Despite the wealth of bottom-living species, only one has left the bottom for the open water community. This species, *Macrohectopus branickii*, is common in the plankton. In the lakes of North India *Cammarus* (*R.*) *pulex* is a common benthic form, which has become pelagic in a single lake, one which lacks fish (Uéno, 1934).

Bazikalova has studied the breeding periods of five gammarids, according to the *Zoological Record* but the paper (1941) itself was unavailable.

Crustacea, Ostracoda

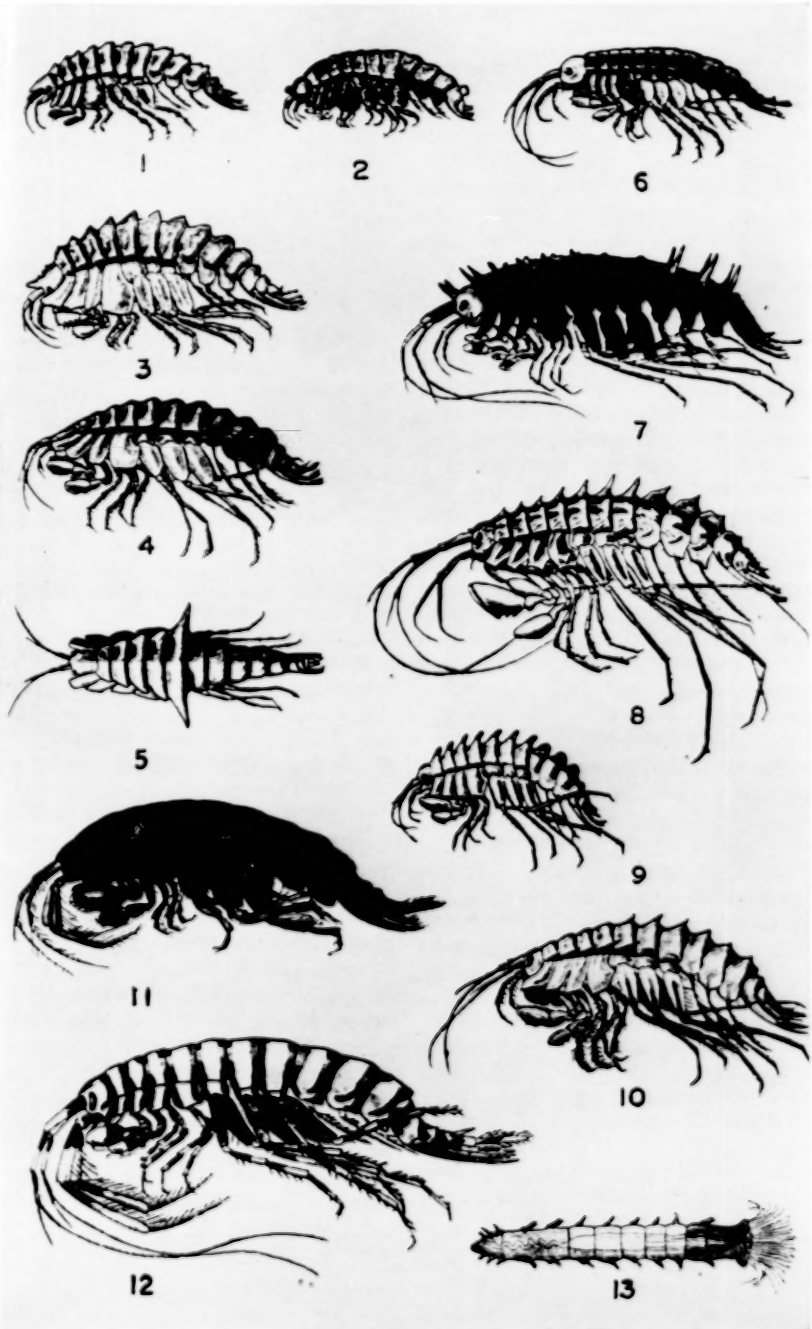
These small bottom-living crustaceans have been recently studied by Bronstein (1936), who finds that the 36 Baikalian forms known belong to three genera, *Candona* and *Pseudocandona* (Cypridae) and *Cytherissa* (Cytheridae).

There are eight endemic species of *Pseudocandona* in Baikal and only 3 species found elsewhere. One of these extra-Baikalian species is known from subterranean basins in Switzerland (*P. zschokki*); the second, living in small open basins, is widely scattered throughout Europe but is rarely encountered (*P. insculpta*); the third has been found in Lake Windemere (England) and Lake Ochrid (Jugoslavia). It is very likely that two other cavernicolous species also belong to this genus, but this assignment is not definite, as no males have been found. The Baikalian species of *Pseudocandona* possess several characters which indicate an organization not only more primitive than that of non-Baikalian species, but also more primitive than is found in any other of the non-swimming genera of its subfamily. (Heavy shell, trapezoidal form, undivided penultimate joint of second antennae in male and lack of sexual setae thereon, undivided penultimate joint of sensory legs, and

FIG. 3. REPRESENTATIVES OF THE BAIKALIAN FAUNA, PART 2

1, *Hyalellopsis grisea* Dor., length 23 mm. Sublittoral, Southern Province.
2, *Hyalellopsis clavata* Dor., length 11 mm. Sublittoral, Littoral.
3, *Boeckaxelia carpenteria elegans* (Dor.), length 35 mm. Sublittoral, Small Sea Province.
4, *Boeckaxelia potanini* (Dor.), length 34 mm. Sublittoral, Selenga Province.
5, Same, in dorsal view.
6, *Pallasea brandtii flaviceps* Dor., length 33 mm. Sublittoral, Selenga Province.
7, *Pallasea bicornis* Dor., length 43 mm. Sublittoral, Small Sea Province.
8, *Brachyuropus nassonowi* Dor., length 60 mm. Transitional, Southern.
9, *Acanthogammarus flavus rodionowi* Dor., length 20 mm. Sublittoral, Southern.
10, *Acanthogammarus godlewskii brevispinis* Dor., length 55 mm. Sublittoral, Selenga Province.
11, "*Echinogammarus*" *melanochlorus* Dor., length 45 mm. Littoral.
12, "*Echinogammarus*" *virgatus* Dor., length 94 mm. Transitional, Northern.
13, *Manajunkia baicalensis* (Nusbaum), length 5 mm. chiefly Sublittoral.

(1–3, 7, 11, 12, from Dorogostaisky, 1930; 4–6, 8–10 from Dorogostaisky, 1922; 13 from Nusbaum, 1901. Retouched.)


1
2
6
3
7
4
8
5
9
11
10
12
13

absence or feeble differentiation of genital appendages in female.)

The ten species of Baikalian *Candona* occupy a rather isolated position with regard to many non-Baikalian forms, according to Bronstein. They possess not only several primitive characters (trapezoidal shape, reticular sculpture of shell, undivided penultimate joint of sensory legs, female showing feeble development of genital appendages), but three species also have claws on the first antennae, a condition unknown in any other member of the family Cypridae. The ostracod which Bronstein identified as *Candona inequivalvis* var. *baicalensis* is the only Baikalian form which resembles a non-Baikalian species, and is presumably a geographical subspecies.

Eighteen species and subspecies of *Cytherissa* have been described from Baikal, whereas only one species is known elsewhere, this occurring in large freshwater lakes in Eurasia and Japan. The latter species, *C. lacustris*, is parthenogenetic, whereas all of the Baikal species are amphigonic, undoubtedly the more primitive condition. Thus Bronstein believes that, with the single exception noted above, the species group of each genus has developed in the lake, each represenring the derivatives of ancient stock which have been long isolated.

Crustacea, Copepoda

The only species flock among the copepods is to be found among the bottom-living harpacticoids. Five closely related species of *Moraria* were described by Borutzky (1931), who considered that they constitute the subgenus *Baikalomoraria*. Five other canthocamptids also were described. The harpacticid *Harpacticella inopinata* Sars has an interesting extra-Baikalian distribution which will be subsequently discussed. No reference to the remainder of the 37 harpacticoid species listed by Vereščagin could be found.

Among the several planktonic calanoids the temorid *Epischura baicalensis* Sars is noteworthy. Its ecology and distribution will receive comment later.

Teleosts

The fish fauna of Baikal presents great interest for the student of speciation, inasmuch as it includes a group of peculiar cottoid fish in addition to representatives of many widespread Palaearctic genera. These endemic cottoids claim first attention. Eighteen species have been assigned to ten genera (Berg, 1928; Taliev, 1935, 1946). Two species clearly belong to the holoarctic *Cottus*, *C. kneri* Dyb. and *C. kessleri* Dyb. The manner of relating the other nine genera is disputed. Berg has grouped them into two endemic families, the Cottocomephoridae and Comephoridae. The latter would contain a single genus *Comephorus*, with its two pelagic species *C. baicalensis* (Fig. 2, *18*) and *C. dybowskii*. The question of the origin of two pelagic species in the lake is of considerable importance, but its consideration will be more appropriate in a subsequent section. This genus, although undoubtedly related to the former group, differs greatly from them. This divergence in structure is correlated with the pelagic habit of *Comephorus*, for one species of cottocomephorid, *Cottocomephorus grewingki* (Dyb.) (Fig. 2, *17*), which has also left the bottom for the open waters, exhibits similar modifications. Berg (1940) separates this latter species, as the sole member of the subfamily Cottocomephorini, from the six bottom-dwelling genera (*Abyssocottus*, *Cottinella*, *Limnocottus*, *Batrachocottus*, *Asprocottus*, *Procottus*) which constitute the Abyssocottini. The recently described (Taliev, 1946) *Mesocottus* should be included in the latter subfamily.

Vereščagin (1940), following Taliev, has believed that these Baikal endemics, with the exception of *Cottus kessleri* and *C. kneri*, should be referred to a single family. Taliev's serological studies (1940) provided some evidence of relationships which are not accounted for in Berg's classification. The genera of Abyssocottini, except for *Cottinella* and *Mesocottus*, which were not examined, fall into two groups. *Procottus* and *Batrachocottus* (Fig. 2, *19–21*) comprise one; *Limnocottus* (Fig. 2, *15*, *16*), *Asprocottus*, and *Abyssocottus* the other. The lack of serological affinity between the two pelagic genera is of considerable interest, *Cottocomephorus* being similar to the first group of bottom forms and *Comephorus* to the second. This concept of relationships based upon serological affinities received confirmation in a subsequent osteological comparison using x-ray photographs (Taliev, 1938, reported in Taliev, 1946), and was further strengthened by Taliev's (1946) discovery of a single specimen of a new bottom-living Baikalian cottoid which exhibits structural similarities to both *Procottus* and *Cottocomephorus*. A new genus *Metacottus* was formed for this specimen.

Turning to the non-endemic fish of Baikal, we

find twelve palaearctic species represented by populations which are little different from those found in other portions of their range. This group includes *Perca fluviatilis* L., *Esox lucius*, two cobitids, 5 cyprinids, 3 salmonids, the gadid *Lota lota* (L.), and *Acipenser bari*. The Baikalian populations of two salmonids are sufficiently distinct to be called geographical subspecies, namely, *Salvelinus alpinus erythinus* (Georgi) and *Coregonus autumnalis migratorius* (Georgi). *Coregonus autumnalis migratorius* is serologically as well as morphologically similar to *Coregonus autumnalis* (Pallas) from the Yenesei River (Taliev, 1940).

Mammalia

The Baikal seal, *Phoca sibirica* Gmelin, is the only mammal living in the lake. Recent serological studies (Taliev, 1940) have confirmed the relation of the Baikal seal to the seal of the Glacial Arctic Sea *Phoca hispida* rather than to that of either Lake Ladoga or the Caspian Sea.

Community Ecology

The associations and the dominant organisms of the benthic communities of Lake Baikal are unique among fresh waters, and even the pelagic community exhibits peculiarities. Diatoms appear to be the most important of the planktonic producers; and copepods, especially *Epischura baikalensis*, and the planktonic amphipod, *Macrohectopus branickii*, are the chief primary consumers of the open waters. Both of these inhabit the open waters from the surface to an undetermined depth below 300 m. The latter, although it has but recently become pelagic, performs a marked diurnal vertical migration (Zachvatkin, 1932). Both species of *Comephorus* feed primarily upon *Macrohectopus* (Vereščagin, 1926). Seals feed on *Comephorus* and other pelagic fish. As most of the littoral vascular plants are restricted to the few calm stretches of the coast, the dominant producers of the littoral benthic communities are algae, especially *Drapanaldia*. Green algae are rare below five meters, although bottom diatoms are found even at depths of 200–300 meters. The bacteria extend to the greatest depths. Benthic consumers in the deeper waters must be ooze-browsers (cf. Lindeman, 1941) deriving their energy from the organic material falling from the open water community in the form of dead phytoplankton and zooplankton and feces. A large part of this organic material is probably metabolized by the bacteria in the ooze before it is ingested by the larger consumers. The gammarids are clearly the dominant benthic consumers, but the polychaete *Manajunkia baicalensis* and molluscs may be locally important (Vereščagin, 1940). The bottom-living cottocomphorids probably feed upon the above-mentioned invertebrates, but no stomach analyses are available.

ORIGIN OF THE BAIKALIAN FAUNA

It is evident from the foregoing discussion that the major part of the Baikalian fauna has no affinity with the organisms which constitute the freshwater fauna of Eurasia at the present time. Any conclusions about the affinities of the Baikalian fauna must be based upon a consideration of the extra-Baikal distribution of close relatives of certain Baikalian groups. Vereščagin has interpreted these distribution patterns to mean that a large part of the fauna, including the gammarids and cottoids, has had its origin from the sea, as an introduction separate from any others which have given rise to the freshwater fauna elsewhere. He has also believed that a certain faunal element represents an archaic freshwater fauna preserved in Baikal but supplanted in most other freshwaters. The most recent statement of his views appeared in 1940. Berg (1935) has taken exception to Vereščagin's hypothesis of marine origin, and has cogently expressed his reasons for believing that the Baikalian stocks are, with the two exceptions noted below, relicts of an ancient freshwater fauna. Both have agreed that two Baikal populations have been derived from the sea. In our discussion of the non-endemic genera of amphipods it was evident that *Gammaracanthus* is the only genus which also occurs in the sea. The population in Lake Baikal has diverged only to the extent of a subspecies. This indicates that it has probably been in the lake for a much shorter time than any of the other gammarid populations. The Baikal seal also is only subspecifically distinct from the typical form of the Arctic Ocean. These two animals, as Berg has emphasized, are the only ones with close marine affinities. There is every indication that they have entered Baikal at a relatively recent time, probably during the marine transgression associated with the glaciation of Siberia. Each was probably introduced from the Yenesei System.

The distribution of the closest relatives of the many Baikalian endemics indicates that they are the relicts of an ancient fauna once widely distributed throughout the freshwaters of Eurasia. Both

Berg and Vereščagin have concurred in this interpretation. These animals constitute what Vereščagin has labelled the "Continental" as opposed to the "Marine" element. A few previously noted groups serve to exemplify this type of distribution. The copepod genus *Epischura* is represented in Baikal by a single species, *E. baicalensis*, which also occurs in a lake on the Kamchatka peninsula. The only other Asiatic species (*E. chankensis*) lives in a Chinese lake. The three other species of the genus live in North American lakes (Garber, 1941). The isopod genus *Mesoasellus*, and *Pseudocandona* among the ostracods, are represented outside of Baikal only by scattered species, many living in caves and subterranean waters of two continents. The distribution of *Sorocelis* even in Asia is discontinuous, and aside from Baikal, it does not occur in Siberia. The presence of a species in a cave in the Ozark Mountains of North America has been noted above. The oligochaetes of the genus *Lamprodrilus* are undoubtedly the most primitive living members of the Lumbriculidae. *Valvata* belongs in this group.

Some paleontological discoveries lend strength to this interpretation. The most pertinent of these, if correct, is that *Benedictia*, now restricted to Baikal, is common in Jurassic freshwater deposits of Transbaikalia (Rammelmeyer, 1940).

A large part of the fauna is composed of stocks which occur in marine or brackish water, or both, as well as in fresh water. The significance of this distribution pattern is controversial. Vereščagin has grouped these stocks with the two populations of undoubted marine origin, calling them the "Marine Element" of the Baikalian fauna. Included are the cottoids, gammarids, *Baicalia*, *Manajunkia*, *Hislopia* (a gymnolaematous bryozoan), and *Harpacticella*, as well as many ciliates and diatoms which will not be discussed, since they are poor material for zoogeographic studies.

The only evidence which Vereščagin has cited (1940) to support his contention that the Baikalian cottoids had their origin directly from marine ancestors is that the postcleithrum, absent or much reduced in the Cottocomphoridae and Comephoridae, is also wanting in *Myoxocephalus niger* Brehm, a marine species of the Far East.

Although Vereščagin has been of the opinion, backed by Bazikalova, that the Baikalian gammarids are of marine origin, there is no longer any direct evidence to support that view. The distribution of the non-endemic genera has been discussed above.

Vereščagin has assumed that *Baicalia* belongs to the Micromelaniidae, a family which occurs today in brackish water along the coast of India, in the Caspian and Aral Seas, in the brackish water of the Black Sea, in the depression of Lombardy, and in the old lakes Issyk-Kul (Siberia) and Erh Hai (Yunnan). Micromelaniids occur abundantly as fossils in deposits around the Black and Caspian Seas, while fossils referred to *Baicala* have been found in Circumbaikalia and Transbaikalia in both Mesozoic and Tertiary deposits. Vereščagin (1940) has considered this to be evidence of the marine origin of the micromelaniids, and hence of *Baicalia*.

Upon comparing the eight sabellids which had been placed in the genus *Manajunkia* by 1935, Zenkewitsch (1935) found that three species show a marked morphological similarity to *M. baicalensis*. These are *M. caspica* (brackish water), *M. aestuarina*, a European brackish water species, and *M. polaris*, a marine species which Zenkewitsch has discovered in great abundance in parts of the littoral region of the Murmansk coast. The type species *M. speciosa* from North American brackish and fresh waters is quite distinct from the above-mentioned group. Zenkewitsch believed that the marine *M. pacifica* (Commander Island) and *M. spongicola* (brackish Chilka Lake, India) should be placed in another genus, which he named *Fabriciella*, but did not define. He was of the opinion that *Manajunkia* had its origin in the freshwaters of Asia and has spread from there to brackish water and the sea.

Whereas most of the freshwater bryozoans of the present day belong to the order Phylactolaemata, the other order Gymnolaemata, largely marine, has a representative in Lake Baikal named *Hislopia placoides* (Fig. 1, *14*). However, species of *Hislopia* also occur in various freshwaters of China, Indochina, and India. *Hislopia* and four other genera are known from freshwater, two being represented in Lake Tanganyika.

Wesenberg-Lund (1896), Rousselet (1906), and Annandale (1911) have all expressed the opinion that these Gymnolaemata have invaded freshwater more recently than the Phylactolaemata. Two of the other genera living in freshwater are known to have marine representatives in the East Indian Ocean, namely, *Victorella* and *Arachnoidea* (Harmer, 1915). However, their presence in old bodies of freshwater, outside of areas of marine transgression in the central parts of Africa and

Asia, raises difficulties of such magnitude that it seems inadvisable to accept this opinion as final.

The harpacticid copepod *Harpacticella* is another genus with representatives in freshwater and in the East Indian Ocean. *Harpacticella inopinata* Sars is Baikalian. *H. paradoxa* (Brehm) lives in Erh Hai (Brehm, 1924, 1931) and *H. lacustris* Sewell is found in the Indian coastal lake, Chilka.

As previously mentioned, Martinson considers the Lubomirskiidae to have developed from the Renieridae independently of the Spongillidae, widely distributed throughout present freshwaters. He also has expressed the opinion that they have come from the sea more recently than the Spongillidae and therefore belong to Vereščagin's "Marine Element." If this is correct, the presence of a *Baicalospongia* in a snall lake in Uriankhai is difficult to explain.

Although Vereščagin has claimed that the family Graffillidae to which the rhabdocoel *Baikalellia* pertains is typically marine, Berg (1935) has shown that this is not justified by the evidence.

Acceptance of the interpretation espoused by Vereščagin that a large part of the Baikalian fauna has been derived from the sea independently of, and more recently than, that widely expanded in fresh waters necessitates the postulation of a geologically acceptable explanation of the introduction of these marine organisms into Lake Baikal. As there are no marine deposits in or near the Baikal basin of late Mesozoic or Cenozoic age the possibility of the lake's site having been occupied by an arm of the sea is excluded. The explanation advanced by Vereščagin is that a small marine basin somewhere in the vicinity of Baikal lost its connection with the Cretaceous sea and began to freshen with the inflow of land drainage. Some of the marine organisms trapped in such a basin would be unable to tolerate the decrease in salinity. Others could. Some of these more tolerant stocks eventually became completely adapted to the freshwater environment. These might then spread into connected fresh waters. Thus would Baikal have received its derived marine element. Derjavin (1924) has expressed the belief that this is the manner in which the greater proportion of the earth's freshwater organisms have accomplished the transition.

With acceptance of Berg's interpretation that the major Baikalian stocks are relicts of an ancient freshwater fauna, a consideration of its origin is unnecessary here.

THE MODE OF EVOLUTION OF LACUSTRINE SPECIES FLOCKS

Each person who has studied the taxonomy of one of the various species flocks in old lakes has concluded that the species group under consideration has evolved in the lake. Dorogostaisky (1923), studying the Baikalian fauna, and Moore (1903), studying those of Tanganyika and Nyasa, have independently expressed the opinion that intra-lacustrine geographical factors were involved in the evolution of the species flocks. However, Woltereck in 1931 advanced the hypothesis that the evolution of these lake swarms is entirely different from the geographical speciation evident in many terrestrial organisms. The essence of his hypothesis is that a population in an old lake might suddenly split into many subpopulations each adapted to a different ecological niche. He adduced no critical evidence in support of this hypothesis. Although some freshwater biologists have exhibited a tendency to accept this hypothesis, Mayr has so ably criticized this and other hypotheses of ecological speciation (1942, 1947) that no more need be said here. However, Mayr considered that, since Woltereck's hypothesis was invalid, species flocks could not evolve within a lake. This led him to postulate that these lacustrine species flocks originated through multiple introductions of closely related species. This might be accomplished in two ways. The first would be by a series of introductions of related populations from the various waters with which an ancient lake might have been continuous during the course of its long history. The second would be by the merger of a series of related populations which had hitherto enjoyed spatial isolation long enough for the development of specific distinctions.

It is now our task to examine this hypothesis of multiple colonization in the light of the extensive data which have been gathered concerning the species flocks in Baikal, as well as the suggestion that intra-lacustrine geographical factors are involved in species flock formation. Let us first consider the second type of multiple introduction. According to this, the species flocks of Baikal arose by amalgamation of a series of lakes each of which contained a number of endemic species. By this fusion these endemics were thrown together, forming species flocks. There is no direct evidence about the antecedent waters from which Baikal received its fauna. If Vereščagin's interpretation is correct, the possibility that there were two lakes must be considered, because the marine stocks may have

been in one while the ancient freshwater stocks were in the other. If this was so, it is obvious that not even species pairs would be formed as it is unlikely that the same genera would be represented in each body of water. Berg's interpretation does not require more than one body of freshwater. Yet, to explain the origin of the largest species flock, that of "*Echinogammarus*," it must be assumed that there were at least 24 separate basins each of which had been isolated sufficiently long for its "*Echinogammarus*" population to have become specifically distinct. This is highly improbable.

The other type of multiple colonization requires that there have been a series of invasions of closely related species from adjacent waters during the history of Baikal. Invasions would be possible either by capture of the lake by different river systems or by the coalescence or connection of the larger lake with adjacent ponds and small lakes. The former seems a priori the more likely, since the cool waters of a large lake such as Baikal are more easily invaded by species adapted to life in rivers and streams than to life in small ponds, wherein the temperature is apt to be much higher during a part of the year.

There is direct evidence to indicate that continuity of Lake Baikal with waters supporting a different fauna has not been followed by an interpenetration of the two faunal groups. At the present time several lakes along the coast of Baikal drain directly into the larger lake through short rivers. The biota of these lakes is the same as that widely distributed in Siberian freshwaters. Furthermore, the biota of several shallow lagoons broadly connected with the open waters of Baikal itself is dominantly Siberian and not Baikalian. This is understandable when it is appreciated that each fauna is adapted to its own environment, and that invaders of the foreign environment must compete with their well-adapted ecological equivalents. The Siberian fauna, with a few exceptions, has not been able to compete successfully under the peculiar conditions to which the Baikalian fauna is so well adapted. The greater part of the Baikalian fauna adapted to cool waters has not been able to compete successfully along those small reaches of its shore characterized by high summer temperatures with the Siberian fauna adapted to a greater temperature fluctuation. The only Baikalian species which have been notably successful in competition with their Siberian equivalents are a few gammarids adapted to the littoral zone of the lake. In the very shallow waters fringing one of the large bays of Baikal, the Small Sea, the biota is dominantly Siberian; but one of the ubiquitous Siberian elements, *Gammarus* (*Rivulogammarus*) *pulex*, is missing. Its place is taken by several Baikalian gammarids, of which one is *Brandtia fasciata*. Furthermore, *Brandtia fasciata* has been able to invade the shallow lagoons and lakes opening into Baikal and even to spread into the Yenesei River System. The most reasonable explanation is that some of the numerous Baikalian species have become adapted to the same environment as *Gammarus pulex* and can successfully compete with it on its home territory.

The Baikalian fauna has been able to withstand invasion from adjacent waters for the greater part of its history. Martinson has found that throughout the Cenozoic there were smaller lakes near the Baikal basin, but these were always populated by widely distributed contemporary species of which there is no trace in Baikal.

Leaving the possibility of invasion from adjacent ponds and lakes, let us now consider the alternative, that of the capture of the drainage of Baikal by different major river systems, with consequent possibility of multiple introductions. There is no evidence that Baikal has even been a part of any system other than the Yenesei. The present outlet, the lower Angara River, flows from the southern basin, which is claimed to be older than other parts of the lake, a view which makes it probable that this is the original outlet. However, it is possible that the Angara once drained into the Lena, which at present has headwaters not far to the north, and that the Angara has subsequently been captured by the Yenesei. It is also possible that Baikal might have drained NE, through a reversal of flow in the upper Angara, into the Vitim, a tributary of the Lena. Should these or any other connections with the Lena have occurred, they do not provide an explanation of the large species flocks.

It is of interest to note here that all evidence indicates that the Angara-Yenesei River system which drains Baikal has supplied only one gammarid to the lake, while it has been invaded by numerous species which have almost certainly evolved in the lake. Its gammarids, triclads, molluscs, sponges, and bryozoans are all similar to Baikalian stocks. Among the gammarids (Dorogostaisky, 1916) and snails (Lindholm, 1912) living in the Lower Angara near Irkutsk the usual Siberian species are known to be wanting. Although many

of its organisms are similar enough to be placed in the same species as the lacustrine forms, five Angara gammarid populations are considered subspecies, one (*Hetergammarus brachyurus*) is specifically different, and one species has been placed in the fluvial genus *Fluviogammarus*. This Baikalian element was known, prior to 1923, as far as 200 km. down the Angara. Although a complete faunal study of the drainage system has not been published, the malacostracan fauna of the Yenesei River is known. Gurjanova (1929) found that three endemic species of amphipods which are common in the shallow waters of Baikal, namely, "*Echinogammarus*" *viridis*, *Brandtia fasciata*, and *Micruropus wahli*, can be found in the Yenesei system. Pirozhnikov (1931), in another examination of the gammarid fauna, did not find either of the last two species, although *Micruropus vortex* and *M. glaber* were present at the station sampled. "*E.*" *viridis* was the only Baikalian species which Pirozhnikov found in the Yenesei River above the entrance of the Angara, although Gurjanova found *B. fasciata* both above and below. All of the gammarids found in the Yenesei are also found among the 27 species and subspecies that inhabit the upstream portion of the Lower Angara. The long narrow Yenesei Gulf of the Arctic Ocean is greatly freshened by the river, but the Baikalian species have been unable to colonize those waters, where nine species of euryhaline marine malacostracans are abundant. In the river delta at the head of the gulf elements of the two faunas meet. *Pontoporeia affinis* and possibly *Mesidothea entomon* are the only gulf species which have been able to invade these waters. Only one amphipod of Baikalian origin has succeeded in establishing itself here, and has diverged from the parent species *Brandtia fasciata* sufficiently to be differentiated as *Brandtia fasciatoides*.

The length of time during which the fauna of the Yenesei has been influenced by the Baikalian element is, of course, undetermined. At the time of maximum Pleistocene glaciation, the Angara and the upper part of the Yenesei System were in unglaciated territory, and the latest advance did not reach even the mouth of the Yenesei. Whether the Baikalian species invaded the river before, during, or subsequent to periods of glaciation is a problem which cannot as yet be answered, although a recent date is more probable.

We may therefore conclude that none of the possibilities of multiple colonization, whether singly or in combination, can account for the origin of the species flocks in Baikal. As the hypotheses of multiple colonization are untenable as an explanation of the evolution of the species flocks of Baikal, it is necessary to examine thoroughly the possibility of geographical speciation within the lake.

The distribution of bottom-living forms might be affected by geographical barriers within a single basin. The large species flocks in Baikal, the turbellarians, molluscs, cottocomephorids, and amphipods are all bottom-living animals. Their activities are as closely confined to the substratum as those of terrestrial animals are to theirs. Only a single species of gammarid, *Macrohectopus branickii*, has left the bottom community. Unlike the African rift lakes, where the bottom waters are devoid of oxygen, there is ample oxygen in Lake Baikal down to the maximum depth. The area of the substratum available for exploitation by bottom-dwelling forms has therefore a considerable vertical as well as horizontal extension. Within this tremendous range, it is possible that ecologically similar areas might be isolated for periods sufficiently long to permit their benthic populations to undergo considerable genetic divergence. Evidence for intra-lacustrine geographical speciation can only be the existence of geographical subspecies and allopatric, as well as sympatric, species within the lake.

The presence of closely-related species in the open water community, species which have undoubtedly evolved within the lake, is exceptional. Vereščagin (1926) has concluded that there are two species of pelagic *Comephorus* in Baikal, *baicalensis* and *dybowskii*. These constitute the only known exceptions (Vereščagin and Sidorychev, 1929). The habits of the two are similar. Both live only in the open waters of the lake well away from the shore and feed primarily upon *Macrohectopus*. Both range throughout the greatest part of the vertical extension of the open water community. Both are regularly found in the surface waters in winter, although in summer only *C. dybowskii* is to be found at the surface. The young are always there, but the adults migrate to deeper strata during the day. No statements on differences in the horizontal distribution of the two species have come to the attention of the reviewer. These two similar species maintain their identity because of a difference in the time of breeding. *C. dybowskii* reproduces in February–March, whereas *C. baicalensis* breeds during July–August. The only way in which these two species could have arisen is through separation of the lake into two basins,

thus isolating two populations. Evidence that such a separation probably has occurred will be discussed in a later section.

It is indeed fortunate that Dorogostaisky realized the importance of learning as much as possible about the distribution of the species comprising the fauna of Baikal, so that we have a picture of the distribution of the bottom forms here as we have in no other large lake. He published the results of this investigation in 1923, presenting his findings, which were based primarily on the distribution of the amphipods, in terms of a series of vertical zones and horizontal regions of the bottom. Some species and subspecies were restricted to each of these vertical and horizontal divisions, while others extended through several divisions, either vertical or horizontal, or both. As the Baikal amphipods are the only freshwater species flocks whose intra-lacustrine distribution is known to any degree of completeness, it is essential that not only Dorogostaisky's conclusions but also the bases for these conclusions be clearly comprehended.

Of the 291 amphipod species stated by Vereščagin (1940) to live in Baikal, it has been possible to ascertain the generic assignments of 143, or about one-half of the stated total, from the taxonomic works of Dorogostaisky and Bazikalova, and from Berg's (1928) summary. The distribution of these 143 species among the 30 known genera is shown in Table 2. Dorogostaisky was able to discover the limits of distribution of 85 of these species. Although he found four vertical zones to which various species were limited, only the boundary between the deepest two is indicated on the map. The bottom of the lake within this 300 meter depth line is called the Central Abyssal Province. At least 33 species are restricted to it. Fifty-six species are known to be limited to the bottom shallower than 300 meters. Each of these species is, however, not found in all parts of this belt. On the basis of the differences in their distribution, Dorogostaisky has delimited five regions of the bottom shallower than 300 m. These regions are indicated in Fig. 1. The greatest length of shore belongs in the two large regions which Dorogostaisky labelled the Northern and Southern Provinces. He cited 26 species which are limited to the smaller Southern Province and 20 others limited to the Northern. The smaller provinces called Isle, Small Sea, and Selenga, have only six, three, and one species, respectively, restricted to them, but each of the last two is characterized as well by the presence of subspecies of otherwise homogeneous, wide-spread populations. Nowhere has Dorogostaisky reported the total number of species which are found in the shallow waters of all parts of the lake, although he does state that there are many such species.

The vertical distribution of the gammarids will be considered first. Dorogostaisky found that the vertical ranges of different species tend to have similar limits, which correspond to ranges of environmental characteristics such as temperature, amplitude of diurnal and annual fluctuations, light, and type of plant and nature of bottom sediments. The areas of distribution of other elements of the bottom fauna coincide with those determined from the distribution of the species of amphipods. On this basis he divided the bottom into four vertical zones: the Littoral, 0–5 m.; the Sublittoral, 5–50 m.; the Transitional, 50–300 m.; the Abyssal, 300–1800 m.

A brief description of the environmental characteristics of each zone and the morphological characteristics of the gammarids of each has been summarized from Dorogostaisky's paper. The Littoral Zone has the greatest diversity of bottom relief and physical conditions, i.e. temperature and light. Most of the bottom is pebbly, with occasional large stones. There are few sandy shores. The largest stretch of sand is near the mouth of the Selenga River, and similar deposits are found at the mouths of other large rivers and in the deep bays. These waters are seldom calm, as wave action is considerable. The amplitude of diurnal and annual temperature fluctuations is greatest here. The light intensity is high. Green algae (*Ulothrix zonata* and species of *Draparnaldia*, *Tetraspora*, and *Oedogonium*) and diatoms are the dominant producer organisns in this zone; vascular plants grow only in calm, protected places. The gammarids of this zone are mostly green or brown. Their bodies are compact and their appendages relatively short. Their eyes are brownish-green or black. "*Echinogammarus*" *melanochlorus* (Fig. 3, *11*) exhibits typical Littoral modifications.

The bottom in the Sublittoral is also diverse in character, with pebbly and sandy places as in the Littoral, and silty regions in deep bays and opposite the river mouths. Wave action is almost absent. The diurnal temperature fluctuations are much less pronounced, and the amplitude of the annual cycle is slightly less than in the Littoral.

TABLE 2

Vertical distribution of genera of gammarids in Lake Baikal
(Based primarily on Dorogostaisky, 1922, 1923, 1930, 1936)

GENUS		NO. SPECIES IN BAIKAL	NUMBER OF SPECIES CHARACTERISTIC OF			
			LITTORAL	SUBLITTORAL	TRANSITIONAL	ABYSSAL
"Echinogammarus"	Stebb.	$27^{B,D}$	4	7	4	5
Pallasea	Bate	$12^{B,D}$	3	2	3	2
Brandtia	Bate	4	$1^{(+)}$	1	1	—
Odontogammarus	Stebb.	7	—	4	2	1
Parapallasea	Stebb.	5	—	1	3	1
Hyalledopsis	Stebb.	many	many^{D}	many^{D}	—	1^{BZ^3}
Micruropus	Stebb.	$13^{B,D}$	+	+	—	—
Boeckaxelia	Schell.	4^{S}	—	3	1	—
Acanthogammarus	Stebb.	11^{B}+	—	many^{D}	5	—
Poekilogammarus	Stebb.	6	—	4	2	—
Carinogammarus	Stebb.	7^{B}	—	—	1	1
Ommatogammarus	Stebb.	4	—	—	3	1
Hakonboeckia	Stebb.	$2^{D,BZ_1}$	—	1	—	1
Microgammarus		+	+	—	—	—
Heterogammarus	Stebb.	4^{D}	—	1	—	—
Crypturopus	Dyb.(?)	3^{D}	—	3	—	—
Echiuropus		1^{B}	—	1	—	—
Carinurus	Sow.	6^{BZ_1}	—	1	—	—
Plesiogammarus	Stebb.	2	—	—	2	—
Gammarosphaera	Baz.	1^{BZ_1}	—	—	1	—
Gymnogammarus		1	—	—	1	—
Brachyuropus	Stebb.	3	—	—	—	2
Ceratogammarus	Sow.	$3^{D,BZ_1}$	—	—	—	3
Garjajewia	Sow.	$4^{D,BZ_1}$	—	—	—	4
Abyssogammarus	Sow.	9	—	—	—	9
Coniurus	Sow.	2^{BZ_2}	—	—	—	1
Polyacanthisca	Baz.	1^{BZ_2}	—	—	—	1
Gammaracanthus	Sow.	1	—	—	—	—
Spinacanthus	Dor.	4(?)	—(?)	—(?)	—(?)	—(?)
Macrohectopus	Stebb.	1	—	—	—	—Planktonic
Total no. of genera		30	6	15	13	14
Species		147+	8+	29+	29	33

KEY:
B—Berg, 1928.
BZ_1—Bazikalova, 1935.
BZ_2—Bazikalova, 1936.
BZ_3—Bazikalova, 1937.
D—Refers to works of Dorogostaisky.
+—(Dor., 1930) *Brandtia lata* is split into 6 horizontal, shallow-water subspecies.
S—Schellenberg, A., 1940.

Because of the great transparency of the water, this zone is well illuminated. *Chara* and bottom diatoms are here the dominant lower plants, green algae being rare. *Potamogeton* and *Ceratophyllum* and other vascular plants can occasionally be observed. The body color of gammarids of the Sublittoral is often yellow or red, although whites, greens, and browns do occur. The body tends to have a less well developed exoskeleton, and the appendages are relatively longer. Eyes are usually black, brown, red, or yellow, more rarely white.

In the Transitional Zone the bottom is more uniform, largely silt, with occasional patches of sand or pebbles. Here the environment is nearly static. Even annual temperature fluctuations are insignificant. Wave action does nor affect this zone. Very little light penetrates so deep. Diatoms appear to be the only photosynthetic plants which can exist here. The gammarids of this zone are most diverse in body form. The greater the depth at which they live, the longer are their appendages (Fig. 3, *8*, *12*). The most prevalent species are yellow and red, but there are many white ones. "*Echinogammarus*" *virgatus* (Fig. 3, *12*) is pink and white. The relative length of its appendages is apparent upon comparison with the Littoral species just above it.

The Abyssal Zone provides an unchanging environment, ever cold (3.2°–4.0°C.) and dark. Diatoms sometimes manage to live as far down as 500 m., and below this bacteria are the only plants. The abyssal gammarids are distinguished by their large size, long appendages, and poorly developed exoskeleton. As in the zone above, most are colored yellow or pink, although white prevails among the most profundal. Their eyes are either pigmented (black, blue, purple, red) and extremely large, or unpigmented and quite small.

Dorogostaisky has not given the vertical range of each species, but for each zone he listed the characteristic species, with particular emphasis on those forms with limited distributions. This information is summarized in Table 2. There are undoubtedly a few species found in many of these arbitrary divisions of the bottom, although Dorogostaisky provided little information on this point. *Boeckaxelia carpenteri* is one of the more widely spread species, which in its typical form is characteristic of the sublittoral of both North and South basins and has a subspecies *profundalis*, living in the Abyssal Zone of the Northern Province (Bazikalova, 1937). (For another subspecies see Fig. 3, *3*.) There are records of several species that live over the boundary of either zone adjacent to that characteristic of the species (Dorogostaisky, 1922). However, it is clear from this study that the area of distribution of the majority of species of amphipods is limited to a fraction of the total vertical extension which is exploitable.

The basis for the demarcation of various parts of the bottom of Baikal, shallower than 300 meters, was the presence of several recurring distribution patterns which Dorogostaisky discovered in his study of the distribution of the 56 species living along this strip of the bottom. Dorogostaisky implied that some populations have a wide, possibly a lake-wide, horizontal distribution, although he never enumerated them. Another distribution pattern is that of species, otherwise widely distributed throughout the lake, which have readily distinguishable subspecies in the region adjoining the mouth of Selenga River. These provide the basis for the differentiation of the Selenga Province. Many species are restricted to the shore of the southern basin while related species occur along the shore of the central and northern basins, except in the smaller provinces. A single known species is divided into Northern and Southern subspecies. The Northern and Southern Provinces are thus indicated. There are six species of gammarids known to be restricted to the shallow waters around the Ushkanii Islands. Dorogostaisky called this region the Isle Province. There is only one long stretch of open coast which has a biotic assemblage different from that of the Northern and Southern Provinces. This is the east coast of a part of the south and central basins adjoining the Selenga Delta, called the Selenga Province. The Small Sea, the body of shallow water between Olchon Island and the west coast, also has a fauna characterized by populations specifically or subspecifically different from those of the open coast. The bottom of the Small Sea constitutes the Small Sea Province.

Dorogostaisky considered that the fauna of the Central Abyssal Province was similar throughout. However, Bazikaloba (1937) showed that the differences in the composition of the amphipod fauna of the southern and central deeps, which Dorogostaisky believed due to inadequate sampling, are real. The 550 meter contour indicated on the map (Fig. 1) as a heavy pecked line, shows this division of the bottom below this depth into southern and northern regions.

It is of considerable interest to be able to determine the horizontal and vertical distribution,

within this general pattern, of all the members of the species flocks, and it is disappointing to find that only a single genus is sufficiently well known. This genus, *Odontogammarus*, is well defined and consists of seven species (Fig. 4). Dorogostaisky considered that *Od. calcaratus* resembles the ancestral species most closely. *Od. calcaratus* is common in the southern half of the lake, but is also present in the north. It is most abundant at depths of 80–100 m. but can be found between 30 and 300 m., and therefore is characteristically Transitional. In the South there is another Transitional species, *Od. pulcherimus*, common between 30 and 200 m. *Od. korotnewi* has been taken at several places in the Northern Province, including the entrance to the Small Sea and around the Ushkanii Islands. It is commonest at depths of 80–100 m. In 1925 Dorogostaisky recorded *Od. brevipes* only from Chivyrkui Gulf, but in 1923 he listed it as characteristic of the Northern Province. However, in his introductory remarks (1923) concerning this province he stated that the Gulf of Chivyrkui and Bargusin may have to be considered as separate zoogeographic units, because of the unusual characteristics of their faunas. As no additional records are given, we must assume that *Od. brevipes* is restricted to Chivyrkui Gulf, at a depth of about 50 m. The fifth species, *Od. improvisus*, is found only around the Ushkanii Islands and near the entrance of Chivyrkui Gulf at depths of 80–100 m. The remaining two species live at greater depths than those aforementioned. *Od. margaritaceus* Dyb. is found primarily at great depths (150–1500 m.) in both the south and middle basins. *Od. demianowiczi* Dor. is restricted to an area of the bottom 200–400 m. deep near the "Great Cat" hole in the south basin. This body of information on the distribution of *Odontogammarus* is the most comprehensive data on the distribution of the members of any lacustrine species flock.

The pattern of distribution of the component populations of a genus or superspecies of gammarids is essentially the same as that seen among terrestrial animals, such as birds or insects. The origin of such a superspecies of freshwater amphipods is reasonably explained by the same scheme of geographical speciation which Mayr has deduced from the distributions of those terrestrial animals. Although the data for the distribution of other genera of amphipods are not as completely recorded as for *Odontogammarus*, Dorogostaisky has claimed that groups of closely related species within the genera *Pallasea*, *Micruropus*, and *Acanthogammarus* have similar patterns of allopatric distribution. This is also true of a group of subspecies of *Brandtia lata* all living in shallow water. Some of the closely related species are sympatric, as the areas of distribution of both *Od. pulcherimus* and *korotnewi* appear to overlap that of *Od. calcaratus*. It is noteworthy that both of these are considerably smaller than *calcaratus;* are indeed the two smallest species (see Fig. 4). Lack (1944) has pointed out that among birds closely related species which differ considerably in body and bill size often occupy the same habitat. But it is unusual to find such marked size differences in closely related species which are not sympatric. The area of distribution of *Od. demianowiczi* appears to lie within that of *Od. margaritaceus*, while the other species are allopatric, occupying different areas of the bottom (Fig. 5).

Interspecific competition undoubtedly plays the principal role in determining the distribution of these species of amphipods. This competition must be primarily for food, which must be limited on the bottom of such an unproductive lake. It is a general rule that two closely related species cannot occupy the same ecological niche (Gause's Principle). When two closely related but reproductively isolated species come together for the first time, there can be any of three consequences. One may exterminate the other. If they do not overlap completely in their exploitation of the available food, natural selection will favor those individuals which overlap the least. In this way the two populations will diverge in feeding habits until the degree of competition is so lessened that the two species can coexist. The size differences in the sympatric species of *Odontogammarus*, probably associated with differences in food size, illustrate this possibility. The third alternative leads to the development of vertically restricted ranges. If the two competing species have slightly different vertical ranges to which they are adapted, each again has a refuge in which it can always compete successfully with its rival. Natural selection will lead to the more complete exploitation of those parts of the vertical range where competition is reduced.

The restriction of a species to a part of its potential range by competition with a closely related species is nicely illustrated by the distribution of triclads in the mountain streams of the Balkans and South Italy. *Euplanaria gonocephala* (Dugès) and *Crenobia teratophila* (Steinmann) occur alone in some streams and together in others. When *E. gonocephala* is alone, it lives in parts of the stream

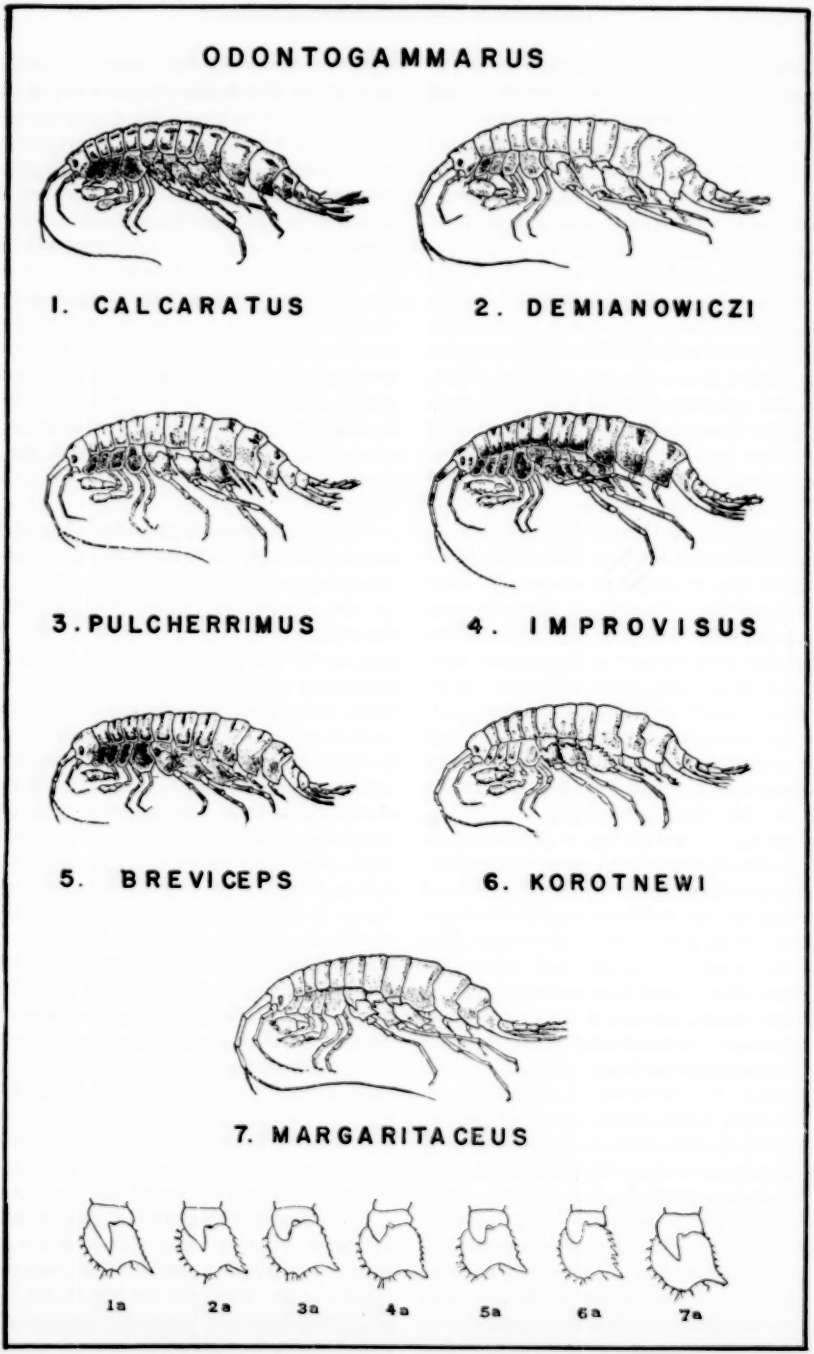


FIG. 4. SPECIES OF THE BAIKALIAN GENUS, ODONTOGAMMARUS

Distribution given in text. Body lengths: 1, 30 mm.; 2, 37 mm.; 3, 20 mm.; 4, 35 mm.; 5, 25 mm.; 6, 18 mm.; 7, 30 mm. 1a–7a, enlargements of the coxal plate and expanded basipodite of the 6th thoracic appendage of above species. (These figures, rearranged, from Plate 2 of Dorogostaisky, 1930.)

where the water temperature is between 8.5° and 23°C., whereas *C. teratophila* occurs in cooler waters, between 6.6° and 16.5°C. Whenever the two species inhabit the same stream, *C. teratophila* extends downstream only to places where the temperature is 13–14°C. Below the point where the water reaches this temperature, *E. gonocephala* replaces the former species and extends downstream until its upper thermal limit is reached. [Beauchamp and Ullyot, 1932. N. B. These authors named the Balkan species involved *Planaria gonocephala* Dugès and *Planaria montenegrina* Chickoff.

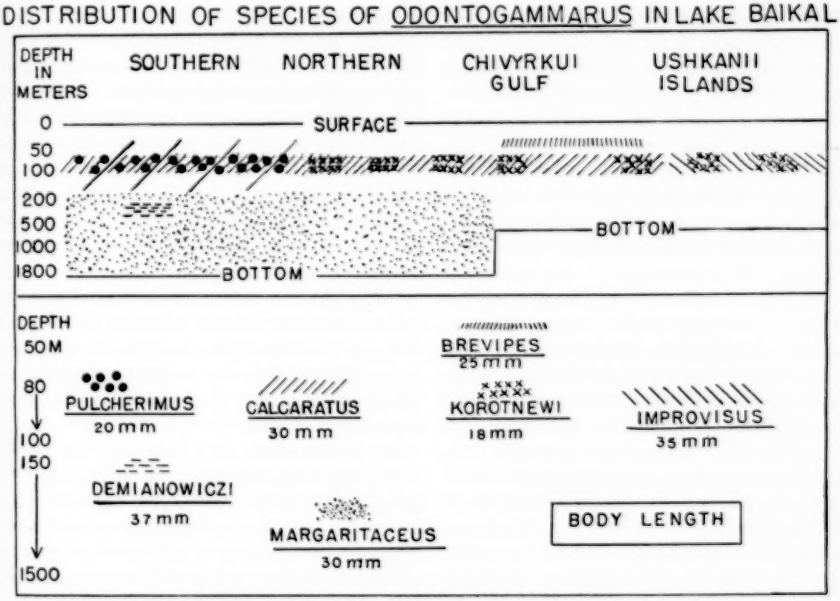


FIG. 5. A DIAGRAMMATIC REPRESENTATION OF THE DISTRIBUTION OF ODONTOGAMMARUS IN LAKE BAIKAL

They assumed the South Italian *Pl. teratophila* Steinmann to be synonymous with the latter. If this assumption is correct, the name should be *Crenobia teratophila* (Steinmann), according to Kenk, 1930.]

THE ZOOGEOGRAPHICAL PATTERN IN BAIKAL

Mayr (1942) has likened old freshwater lakes to old islands, because each permits the survival of conservative elements of otherwise extinct faunas. The comparison is equally useful when each is considered as a geographical region within which speciation can occur; as when, for example, Lake Baikal is compared with New Guinea. The bottom fauna of the Littoral, Sublittoral, and Transitional Zones of Baikal are as completely isolated by the open waters of the lake from those on the other side as the birds living near sea level on one side of New Guinea are isolated by the central mountains from those on the other side. The differentiation of the Abyssal fauna in the south and central basins has its counterpart in the differentiation of the mountain bird fauna in different ranges of the central New Guinea mountains (cf. Mayr, 1942, Fig. 24). The strips of low and middle altitude land around the periphery of New Guinea, like the Littoral, Sublittoral, and Transitional Zones around Baikal, each have a tremendous linear extension. Any vertically limited population spreading out in any one of these ecological zones will result in an essentially linear population. Such linear populations are prone to geographical speciation. The results of speciation in the birds of New Guinea are admirably illustrated in Mayr's (1942) Fig. 4, showing subspeciation in the whistler *Myiolestes megarhynchos*, his Fig. 15 of the kingfisher *Tanysiptera galeata*, and his Fig. 13 of the races of *Paradisea apoda*.

The long strip of lake bottom adjacent to the shoreline of Baikal passes through regions with

different ecological conditions. Any Littoral or Sublittoral species spreading along the shore will encounter a variety of environments, which they may or may not be capable of invading successfully. An examination of the distribution of the Baikalian gammarids has shown that certain species and subspecies are restricted to certain geographically delimited regions of the lake shore. The fact that many of the amphipods have peculiar species or subspecies restricted to the same sections of the shore made it possible for Dorogostaisky to name these regions and to present the distributional data in relation to them. In order for these populations to have diverged genetically, they must be discontinuous or have been so at some time in the past.

The shallow shore around the Ushkanii Islands is one area which is at present geographically isolated from the rest of the shallow bottom areas of the lake. There is only a narrow strip of bottom shallower than 300 m. joining this shallow area with that of the Holy Nose Peninsula. This Isle Province is ecologically distinct as well, for the temperature of the surface water here seldom rises above 7°C., according to Dorogostaisky. "The fauna of the Isle Province is well characterized by many endemic species" (trans. Dorogostaisky, 1923, p. 121). This endemism is especially evident in the gammarids and turbellaria, although the species of the latter group are largely undetermined. Six species of gammarids are restricted to the Isle Province, *Spinacanthus insularis* Dor., *Boeckaxelia castanea* Dor., *Acanthogammarus maximus* Sar., *Ac. korotnewi* Sar., *Gammarosphaera insularis* Baz. (Bazikalova, 1936), and *Odontogammarus improvisus* Dor. No subspecies are reported, and the presence of representatives of widely spread species was not mentioned. *Spinacanthus insularis* is Sublittoral, and *B. castanea* occurs in both the Sublittoral and Transitional (Dor. 1930). *Acanthogammarus korotnewi*, *Gammarosphaera insularis*, and *Odontogammarus improvisus* are characteristically Transitional. No data are available for *Ac. maximus*. Although Dorogostaisky lists *Hyalellopsis*, *Micruropus*, and *Microgammarus* as characteristic of the Littoral and Sublittoral Zones of the lake in general, no representatives of these genera are recorded from the Isle Province. Possibly the physical environment of the Littoral and upper Sublittoral of the Isle Province is sufficiently different, so that these genera, adapted to the conditions of these zones along the main shore, have been unable to establish themselves. Otherwise it must be assumed that suitable invasion routes have been wanting for a long time relative to the age of the islands.

Each of the other small provinces is ecologically distinct from the adjacent Northern and Southern Provinces, but all are geographically continuous in the same way that the lowlands of New Guinea are continuous. Yet it is apparent from the degree to which subspeciation and speciation have occurred that the populations along these geographically continuous strips must be more or less discontinuous. This is equally true of the birds of the New Guinea lowlands and the gammarids of the shallow bottom of Baikal.

Differences in the nature of the sediments of the shallow bottom are readily apparent. The bottom of the Littoral and Sublittoral Zones which, along the open coasts of the Northern and Southern provinces, is largely rocky and pebbly, is considerably modified in deep bays such as Bargusin and Chivyrkui, and at the mouths of the large rivers, such as the Selenga, Upper Angara, and Chivyrkui. In these places the Littoral bottom is sand, and the Sublittoral sand and silt. Even the Transitional Zone may be altered.

The longest stretch of sandy bottom extends on either side of the Selenga delta and constitutes the Selenga Province. Here the water itself is turbid, very different from the highly transparent water along most of the shore, and the temperature in summer is higher than it is along the open shore. The surface temperature here may reach 19°C. It is not surprising that the fauna of this region has a peculiar aspect. Sponges and turbellarians have not been able to establish themselves in this environment. Thirteen species of amphipods have been recorded from this region, and of these, seven are morphologically indistinguishable from samples taken elsewhere in the lake. However, five widely distributed species are represented in the Selenga region by peculiar subspecies [*Pallasea baicalia intermis* Sow., *P. grubei arenicola* Dor., *Carinurus solskii obscurus* Dor., *Parapallasea puzylli carinulata* Dor., and *Acanthogammarus godlewski brevispinus* Dor. (Fig. 3, *10*)]. *Boeckaxelia potanini* Dor. (Fig. 3, *4–5*) is the one species restricted to this province. It is Sublittoral.

The nature of the populations at the boundaries of the adjacent Southern and Northern Provinces has not been investigated. For these Selenga populations, which have only subspeciated, it is reasonable to assume that either genetic interchange with the adjacent population is not completely interrupted, or, if it has been interrupted, that sufficient

time has not elapsed for the more profound morphological differentiation to have occurred which would be considered speciation.

The two large gulfs on the eastern coast of the Northern Province resemble the Selenga region in certain aspects. Here, too, the bottom is largely sand and silt, and the summer temperatures are much higher than those along the rest of the shore of the Northern Province, for they reach 20°C. (Dor.) Dorogostaisky stated in 1923 that each gulf appears to have its own faunal characteristics, although the amphipods had not been adequately studied at that time. Subsequently Dorogostaisky (1936), in a paper which could not be consulted in the original, published the results of a study of the gammarids of Bargusin Bay. According to the *Zoological Record* a new species, *Micruropus cristatus*, was described, apparently confirming the distinctness of this region of the bottom. It was previously noted that *Odontogammarus brevipes*, although listed (1923) as characteristic of the Northern Province, apparently has been found only in Chivyrkui Gulf (Dor., 1925).

The Small Sea, on the west coast of Baikal, should undoubtedly be classed with the gulfs on the east coast when considering geographical speciation. The Small Sea is not a gulf, inasmuch as it communicates with the open waters of the lake at both ends. The narrow Olchon Gate at the south end of Olchon Island must be considered a part of the Small Sea. This province presents a wide variety of physical conditions, viz., nature of bottom, depth, temperature, and transparency, matched by the diversity and richness of the flora and fauna (Dor.). The vascular plants are well represented here. Although no study has been made of the productiveness of different parts of the lake, it appears that the Gulfs of Chivyrkui and Bargusin and the Small Sea support the largest populations. This is evidenced by the fact that *Manajunkia baikalensis* is extremely abundant in the Transitional zone of the Small Sea and the Gulf of Chivyrkui, but exists elsewhere in sparse populations. Dorogostaisky reports that the planaria are particularly abundant here, listing 33 species. Although 51 species of gammarids occur in the Small Sea (Burow and Koskow, 1932), only about 14 are very common and of these the following are endemic: *Pallasea bicornis* Dor. (Fig. 3, 7), *Hyalellopsis depressirostris* Sow., *Microgammarus chargaensis* Sow., and *Acanthogammarus armatus ongureni* Gar. (Dor.). The typical subspecies of the last, *Acanthogammarus armatus armatus*, has been taken only in the Northern Province (Dor., 1922). The populations of the majority of non-endemic species of the Small Sea consist of individuals morphologically distinguishable from those living in other parts of their range (Burow and Koskow, 1932).

In addition to these large reaches of shallow water, there are several smaller shallow bays along the east coast which are very productive, but whose faunal assemblage is non-Baikalian. Three of these near the Selenga delta, the bay of Proval and Kharauz and Posolsky lagoons, are indicated on the map. Although they are all broadly connected with the main part of the lake, the biota, both planktonic and benthic, is completely different, being comprised of common Siberian species (Dorogostaisky). This is also true of the lakes Froliha, Rangatui, and Katokel, which flow directly into Baikal, and of the many ponds in the Selenga delta. Only a single Baikalian endemic, *Brandtia fasciata*, has successfully invaded these waters, and the common palaearctic gammarid, *Gammarus* (*Rivulogammarus*) *pulex* is abundant. The littoral environment in Baikal is sufficiently different from that of these adjacent bodies of water that the species adapted to the one apparently cannot compete successfully in the other.

There is only one place in the shallower bays of Baikal where representatives of common palaearctic genera have been able to establish themselves, and this is on the shallow bottom fringing the Small Sea (Burow and Koskow, 1932). However, certain of the palaearctic elements common in the small lakes and bays noted above are absent here, being replaced by ecologically similar forms of Baikalian genera. *Gammarus* (*R.*) *pulex*, for example, is never found, its place being taken by littoral species of the Baikalian genera *Brandtia*, "*Echinogammarus*," and *Micruropus*. It is interesting that one of the commonest of these species is *Brandtia fasciata*, which has also been able to invade ponds and lakes connected with Baikal and has spread through the Yenesei River System. "*Echinogammarus*" *viridus*, common in these very shallow baylets of the Small Sea, has also invaded the Lower Angara River and thence the rest of the Yenesei System. The bottom fauna farther away from the shores has few palaearctic species, and in the deeper waters is entirely replaced by a typical Baikalian association.

The fauna along the coast to the north and south of the Small Sea, as well as on the outer side of Olchon Island, is all classed as Northern by

Dorogostaisky. An intensive study of the fauna of the Small Sea by Burow and Koskow (1932) has shown it to be more closely related to that of the Northern than to the Southern Province. There are no data recorded concerning the intermixing of the two faunas at the mouths of the Small Sea.

We now come to the problem of the origin of the Southern and Northern faunal provinces. On the west coast, the Southern fauna is gradually replaced by the Northern fauna about one third the way up from the south end, while the Selenga Province separates the Northern and Southern Provinces on the east coast. There are no large bays in the Southern Province, and its bottom shows little variation, being rocky in the Littoral and upper Sublittoral, becoming sandy in the lower Sublittoral. Excepting the two gulfs and a sandy stretch on the northern end of the lake, the bottom in the Northern Province is very similar. Other physical conditions are also similar, except that the shallow waters at the extreme southern end of the lake attain a higher summer temperature than elsewhere. The two principal provinces therefore show, at the present time, none of the essential ecological differences that are associated with the smaller provinces. Furthermore, the transition from Northern to Southern faunas on the west coast is gradual and not marked by any conspicuous geographical features.

The problem of the origin of the species of the Northern and Southern Provinces is different from that in the other small ones. In the latter there are small numbers of species and subspecies restricted to portions of the lake, each of which not only has its own ecological peculiarities but enjoys partial geographical isolation from the rest of the lake. There is also a correlation between the degree of geographical isolation and the ratio of endemic species to subspecies. In the isolated Isle Province all six of the endemic populations are ranked as species, while in the Selenga Province, geographically continuous with both the Northern and Southern Provinces, there is one endemic species to five endemic subspecies. The Small Sea is intermediate between these extremes, both with regard to degree of geographical discontinuity and relative extent of speciation. There is no genus restricted to any one of these small provinces; all of their endemics have closely related species in the adjacent Northern, and in the case of Selenga, both Northern and Southern faunas. The present conditions of discontinuity are such that we might expect the bottom populations in the smaller provinces to be in the process of subspeciation and possibly speciation. On the other hand, the Northern and Southern Provinces, ecologically very similar to each other and broadly continuous at least on the west coast, have 20 and 25 species restricted to each, respectively, and only a single common species represented by two geographical subspecies. *Acanthogammarus victori* Dyb. is recorded by Dorogostaisky to have Northern and Southern subspecies. The presence of large numbers of restricted species and the apparent lack of present subspeciation, together with the lack of any geographical features which might cause isolation, is most reasonably interpreted as indicating that the differentiation of the Northern and Southern species occurred at a time in the past when the morphometry of the lake was different from what it is at present. And as a corollary, the Northern and Southern faunas must be older than those of the smaller provinces, which appear to be still in the process of subspeciation and speciation.

In our endeavor to ascertain the past existence of any morphometric feature of Lake Baikal which might isolate the Northern and Southern Provinces, it is necessary to include a consideration of the Abyssal zone. Although Dorogostaisky was of the opinion that the species of the south and middle depressions (Fig. 1) were identical, Bazaikalova (1937) has reported that several species are restricted to one of the two depressions. *Garjajewia dogieli* Baz., *Abyssogammarus leptocerus* Dyb., *Ab. sarmatus* var. *echinatus* Baz., *Ab. hydiae* Baz., and *Ab. kusnezowi* Sow. are peculiar to the southern depression, while *Polyacanthisca calceolata* Baz. (a monotypic genus resembling *Abyssogammarus*), *Ceratogammarus acerus* Baz., *Abyssogammarus gracilis* Sow., *Ab. calceolatus* Sow., and *Boeckaxelia carpenteri* f. *profundalis* are found only in the middle depression. The shallow water between the two depressions stands over the Selenga Rise, which extends from the mouth of the Selenga River on the east coast to the Buguldeika River on the west coast. It is not at all clear how shallow the Selenga Rise is. Drizhenko's longitudinal profile (in Fickeler) indicates its top as 150 m. below the surface, while a transverse profile about 80 km. north of this 150 m. sounding shows very shallow water on the eastern end, gradually deepening to a maximum of 530 m. three quarters of the distance toward the west shore. This may mean that there is a

shallow ridge running obliquely to the transverse sounding line.

The transition from Southern to Northern bottom fauna in the Littoral and Sublittoral zones on the west coast takes place over the end of the Selenga Rise, which we have seen separates the Abyssal faunas. Although Dorogostaisky drew the line of demarcation somewhat to the north of the rise at the Cape of Krestovsky, he stated that this replacement of one fauna by the other is in reality gradual. Furthermore, he stated that the northern and southern subspecies of *Acanthogammarus victori* meet at the Buguldeika River, which is very near the west end of the rise. The fauna of the Selenga region, which like that of the Small Sea is probably of relatively recent origin, now separates the Northern and Southern faunas on the east coast, so that we can learn little about the eastern end. It may be fortuitous that the Southern assemblage of bottom amphipods living above 150 meters should be replaced by the Northern assemblage at the same place where a barrier separates the Abyssal fauna of the southern basin from that of the northern part of the lake, but it is also possible that at some time in the past the top of this ridge was nearer to the surface and acted as a barrier for the fauna of the shallower waters as well. This would involve either a lowering of the water level or an elevation of the ridge, or both. Until we know more of the structure of the rise it is impossible to evaluate these possibilities.

Drizhenko's (1908) map and profiles provide the little information available, and two geomorphic interpretations of the structure of the rise have been presented, based upon these diagrams above. Fickeler (1927) and Halbfass (1928) are of the opinion that this rise is formed of sediments deposited by the Selenga River. Johansen (1925) supported this interpretation but did mention the possibility that this rise may be of tectonic origin. Bazikalova (1937) referred to it as a submarine mountain range, but without reference to any geological study. Burow and Koskow (1932) stated that in their opinion it is possible that the Northern and Southern parts of Baikal were isolated from each other at some time in the past, but they made no mention of the implied geographical barrier. It is of the utmost importance that the structure of the rise be more thoroughly investigated, in view of the biological evidence that a barrier has existed at this place in the lake.

Gradual replacement of the Southern by the Northern faunas along the west coast is the pattern to be expected, following the removal of a barrier which had persisted long enough for reproductive isolation to evolve. The closely related species would compete, and a Southern species might extend its range at the expense of that of the Northern member of the subspecies, or vice versa. It has already been stated that at least one species, *Acanthogammarus victori* Dyb., has two geographical subspecies which replace each other near the mouth of the Buguldeika River, somewhat to the south of Cape Krestovka, through which Dorogostaisky drew the dividing line. On the other hand, some Southern species extend as far north as the southern side of the Olchon Straits (Burow and Koskow, 1932).

Should the geological structure of the Selenga Rise prove consistent with the hypothesis that it was at one time a barrier separating Baikal into two lakes, the otherwise inexplicable origin of two pelagic species of *Comephorus* will have a reasonable explanation. During this period of separation the two stocks could have acquired their different breeding seasons, so that they remained reproductively isolated when the geographical barrier disappeared.

Summarizing this investigation of the geographical aspects of the speciation of gammarids in Lake Baikal, it may be said that the ranges of distribution of the restricted subspecies and species of the Littoral, Sublittoral, and Transitional zones are either closely associated with geographical features of the present coastline or, showing the same pattern of distribution, indicate that at some time in the past the lake was completely, or very nearly, split into two lakes which have been subsequently reunited. This barrier is not entirely hypothetical, as there is at the present time a barrier effectively subdividing the Abyssal fauna in the very part of the lake in which a shallow water barrier at some time in the geologically recent past is required. There is every indication that the basin of Lake Baikal has had a long and complex geomorphic past (Presniakov, 1940), only the latest phases of which are indicated by the intra-lacustrine distribution of the present fauna. It is a reasonable assumption that there have been geographical subspeciation and speciation associated in the past with geographical features which acted as barriers to the distribution of once-continuous populations, just as there is at present. With the passage of time these isolated subpopulations may have been re-

joined or further subdivided, as the barriers vanished and were replaced by new ones, giving rise to the large species flocks.

DISTRIBUTION AND SPECIATION OF OTHER BAIKALIAN SPECIES FLOCKS

The information which Dorogostaisky was able to gather about the distribution of the other species flocks is less extensive than for the gammarids. We will consider each group, however, in an endeavor to ascertain the probability of geographical speciation.

All but one species of cottocomphorids are bottom forms. Taken as a group they cover the entire vertical range, but individual species are restricted in their vertical distribution. The known vertical distribution of the benthic cottids is given in Table 3. It is not surprising that none of the cottocomephorids are restricted to the narrow Littoral zone, nor that the young of two species feed there. The restriction of the species of *Cottus* to this narrow zone may be the result of the inability of this recent invader to successfully compete with the adult cottocomephorids of the deeper waters. Adult *Batrachocottus baicalensis* may be excluded from the Littoral zone by such competition, but judging from the deep distribution of most of the cottocomephorids, their absence from the Littoral and their unique representation in the Sublittoral are more probably due to other factors. *Procottus* and *Batrachocottus*, which form a group serologically different from the other Abyssocottini, have a shallower distribution. The young of a single species of *Procottus* and the Sublittoral species of *Batrachocottus* are known to migrate up to the Littoral zone. It is not known whether this habit of vertical migration is restricted to these two related species or whether it may also occur in other species but has escaped detection because the shallowest waters are not penetrated. The vertical discreteness of the ranges of the three species of *Batrachocottus* (Fig. 2, *19–21*) has no parallel in the polytypic genera of the other serological group, both species of *Limnocottus* (Fig. 2, *15–16*) and the three of *Abyssocottus* being restricted to the Transitional and Abyssal zones, respectively. The abyssal monotypic genus *Asprocottus* belongs to this latter group, but the affinities of *Metacottus* and *Cottinella* have not been investigated.

TABLE 3

Vertical distribution of some cottoid fish in Lake Baikal

VERTICAL ZONE	SPECIES
Littoral	*Cottus kessleri* Dyb. *Cottus kneri* Dyb. Young *Procottus jeittelesi* (Dyb.) Young *Batrachocottus baicalensis* (Dyb.)
Sublittoral	*Batrachocottus baicalensis* (Dyb.)
Transitional	*Procottus jeittelesi* (Dyb.) *Batrachocottus nikolski* (Berg) *Limnocottus godlewskii* (Dyb.) *Limnocottus megalops* (Graz.)
Abyssal	*Batrachocottus multiradiatus* Berg *Asprocottus herzensteini* Berg *Abyssocottus korotneffi* Berg *Abyssocottus gibbosus* Berg *Abyssocottus boulengeri* Berg *Metacottus gurwičii*

Dorogostaisky reported that there was no information on the horizontal distribution of the cottocomephorids prior to 1923, and none has appeared since. We would not expect to find many geographical subspecies and allopatric species because of their deep distribution and their motility, which is probably greater than that of the invertebrates. However, it does seem likely that careful investigation might demonstrate that the southern and middle depressions, whose isolation has led to a divergence in the gammarid populations, are different with respect to their cottocomephorids. The presence of more species in the more completely isolated Abyssal than in the Transitional would be expected, and these zones have seven and four species, respectively. The distribution of *Comephorus* has been previously discussed.

Unlike the cottocomephorids, the Baikalian molluscs do not occur in the Abyssal zone, and find their greatest development in the Sublittoral. The Littoral species all belong to the non-endemic genera of gastropods and pelecypods. Indeed, all but two of these genera are restricted to this shallowest water. At least one species of *Ancylus* and three of *Valvata* are reported by Dorogostaisky to inhabit deeper waters. The large endemic genera of gastropods, *Choanomphalus* and *Baicalia*, appear to be most numerous within the Sublittoral, although some species of the latter extend into the Transitional. Dorogostaisky gives the vertical distribution of only one of the 15 species of *Choanomphalus*, namely, *maacki*, which is Sublittoral. Bu-

row and Koskow (1932) indicate that four of the six species of this genus found in the Small Sea live between 3 and 18 m., with one species above and one below. The smaller genera *Benedicta* and *Kobeltocochlea* (Fig. 2, *1–4*) are Sublittoral and Transitional, and in the former we find the only recorded instance of two closely related species of gastropods showing a restriction of their vertical ranges. Dorogostaisky listed *B. baicalensis* as characteristically Sublittoral and *B. fragilis* as Transitional.

It is regrettable that so little is known about the horizontal distribution of the Baikalian molluscs. Dorogostaisky was able to ascertain the distribution of only 19 of the many molluscs of the Northern and Southern Provinces, and those of the smaller provinces has been studied even less. The subsequent work on the Small Sea (Burow and Koskow, 1932) makes it possible to draw some tentative conclusions about distribution and speciation in the molluscs. It is of interest that 6 of the 7 recorded Baikalian species belonging to non-endemic genera are restricted to either the Northern or the Southern Province. Two species of *Limnea* and one each of *Planorbis* and *Physa* are characteristically Northern, while one *Ancylus* and one *Valvata* are numerous only in the Southern Province. Did these invade Baikal while it was two lakes? The seventh species *Valvata baicalensis* has been found in both Northern and Southern Provinces, as well as the Small Sea. *Choanomphalus maacki* is the only member of an endemic genus with a similarly unrestricted distribution. None of the common snails of endemic genera are restricted to the Southern Province, while the genus *Benedictia*, if it does occur there, cannot be very common. The Sublittoral *B. baicalensis* Gerstf. has been found in the Northern Province and in the Small Sea, and the Transitional *B. fragilis* is not found in the Small Sea, whose bottom is entirely Sublittoral.

In the Small Sea, the only province for which a complete faunal list is available, 20 species of *Baicalia* occur. One of these, *B. ciliata* (Fig. 2, *6*), was recorded by Dorogostaisky as characteristic of the Southern Province; another, *B. oviformis*, as characteristic of the Northern. Two other species not found in the Small Sea were listed by Dorogostaisky as being common elsewhere. This fragmentary information indicates that there are allopatric species in the large endemic flocks and that geographical speciation must be considered as possible.

The turbellarians and oligochaetes have been so imperfectly studied from the standpoint of distribution that little need be said of them here, save that there appear to be many allopatric species. Representatives of both groups can be found at all depths in the lake. Dorogostaisky recorded a total of 33 species of turbellarians as characteristic of either the Northern or Southern Province, but none as characteristic of both. Another 32 species were stated by him to be characteristic of the Small Sea, and all are different from those of the Northern and Southern Provinces. Burow and Koskow did not study the turbellaria here. Dorogostaisky reported the presence in the Isle Province of many species of turbellarians not found in other parts of the lake. Those of the Selenga Province are unstudied. Nasonov (1930) recorded the localities where the species of the rhabdocoel *Baikalellia* were found in the Olchon Gate and in the southern basin. This, however, was not primarily a distributional study and did not purport to give the complete distribution of these species. Although Dorogostaisky provided considerable information on the vertical distribution of the oligochaetes, the only clear indication of regional differences in the oligochaete fauna is found by comparing Michaelsen and Vereščagin's (1930) study of the Selenga region and the northwest coast of the lake with that of the Small Sea by Burow and Koskow (1932).

The taxonomy of the Baikalian isopods and ostracods was imperfectly known in 1923, so that the scant information on the distribution of the members of the species flocks of these two groups has become available since Dorogostaisky's paper. Dorogostaisky made no mention of the ostracods, and knowledge of the taxonomy and distribution of these bottom living crustaceans is due to Bronstein's efforts. Although the patterns of ostracod distribution within Baikal have not been comprehended, it appears from the distributional data presented in Bronstein's 1930 paper that some members of ostracodan species flocks are sympatric, while others are allopatric. The picture of isopod taxonomy and distribution is more complete than it was in 1923, when Dorogostaisky considered that there was only one Baikalian species. Five species are now known. *Asellus dybowskii* Semenkewitsch, which Birstein (1939) separated from the other four Baikalian species into the subgenus *Mesoasellus*, was found in the Abyssal zone of the southern basin at a depth of 800 to 1000 m. The four species of the endemic subgenus

Baikaloasellus live in much shallower water, according to Semenkewitsch (1924). *A.* (*B.*) *angarensis* Dyb., the commonest species in Baikal, lives at depths of from 1.5 to 45 m. Although it has been found along the entire coast, it is much more common in the northern and central parts of the lake than in the southern. *A.* (*B.*) *baikalensis* Grube, like the preceding species, can be found throughout the lake, also living between rocks and stones, but it is much more common in the southern part of the lake. This pattern of distribution might be the result of the interpenetration of two closely related species which had diverged while separated into southern and northern subpopulations. It would be of considerable interest if the ecological relationship of these two species could be more intensively studied. The last two species have much more restricted ranges. *A.* (*B.*) *korotnewii* has been taken at several places in the Small Sea and near the Holy Nose Peninsula. Whether or not these latter collections were in either of the gulfs formed behind the Holy Nose Peninsyla was not stated by Semenkewitsch. This species was found on a very shallow stony bottom, at depths of 1–9 m. The known range of *A.* (*B.*) *minutus* is even more restricted, since it was found in only one collection in the south basin near the beginning of the Lower Angara River. A more careful delimitation of the ranges of these two species might provide some idea of the nature of the barriers between these and the two more widespread species.

It would be of considerable interest to compare the pattern of distribution of the bottom-dwelling harpacticoid copepods with that of the other elements of the bottom fauna, but this reviewer was unable to find any pertinent information. Borutzky gave no distributional data. Since Vereščagin (1940) listed 37 species (see Table 1) further work must have been done.

From this brief summary of the other Baikalian species flocks, it is evident that a great deal of work must be done before the distribution patterns for each species flock are established. It is clear that in the better known groups of bottom fauna, geographical speciation associated with the same geographical isolating mechanism which appeared in the study of the gammarids, must be considered not merely possible but also highly probable.

(To be concluded)

NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will occasionally appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not received it. All material for notice in this department should be addressed to H. B. Glass, Associate Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *Department of Biology, The Johns Hopkins University, Baltimore 18, Maryland, U. S. A.*

REVIEWS AND BRIEF NOTICES

General Biology: Philosophy and Education..... 61
Biology: History and Biography..... 64
Ecology and Natural History..... 68
Evolution..... 74
Genetics and Cytology..... 76
General and Systematic Botany..... 77
Economic Botany..... 80
General and Systematic Zoology..... 82
Economic Zoology..... 89
Parasitology..... 90
Animal Growth and Development..... 91
Animal Morphology..... 93
Animal Physiology..... 97
Animal Nutrition..... 103
Biophysics..... 104
Biochemistry..... 106
Microbiology..... 109
Health and Disease..... 110
Psychology and Animal Behavior..... 114
Human Biology..... 119
Biometry..... 124
De Omnibus Rebus et Quibusdam Aliis..... 125

GENERAL BIOLOGY: PHILOSOPHY AND EDUCATION

THE SITUATION IN BIOLOGICAL SCIENCE. *Proceedings of the Lenin Academy of the Agricultural Sciences of the U. S. S. R., July 31–August 7, 1948. Complete Stenographic Report.*

By T. D. Lysenko and others. International Publishers, New York. $5.00. ii + 636 pp. 1949.

THE SCIENCE OF BIOLOGY TODAY.

By Trofim Lysenko. International Publishers, New York. $1.25. 62 pp. 1948.

The most remarkable fact about the last public outbreak of the so-called "Genetics Controversy" in Russia, of which this book is a verbatim transcription, is the utter confusion of science on the one hand and political and social passion on the other. It may, in fact, take its place in history as one of the documents in the struggle between science and politics, a struggle which in our time has come to occupy the central position of (although not entirely superseding) that struggle between science and theology which agitated our grandparents. The fact of greatest importance recorded in these 636 pages, which contain the speeches delivered by 56 participants in the debate of July 31-August 7, 1948, is the loss not merely of a science, but of that objectivity and detachment toward which Western scientific culture has struggled for three centuries. This conclusion has to be drawn from the documents on both sides of the controversy, not only pro and con in Russia, but pro and con in the United States, in Great Britain, in Germany, and in Austria, to name only the countries from which this reviewer has received published material on the debate.

It is difficult, after the passions of opposing parties have been aroused, to rid such a controversy of the strong colors (chiefly bright red and pure white) which have been given to it by the press and personal accounts; yet that seems to me to be the first duty of a reviewer. What is important just now is not only whether this one was "right" and that one "wrong," whether this one lied and that one was honest, for time will render that judgment better than we can at this moment; it is rather to know what the controversy was and why it broke out when and where it did. It is better now to report and to understand than to judge.

The documents in this book leave no doubt as to who began this fight or who the aggressors were. They were the supporters of the agronomist Trofim Denisovich Lysenko, who had begun in the late twenties to publish results of experiments on plants which led

him to believe that the heredity of crop plants could be permanently altered by the proper manipulation of certain factors of their environment, such as temperature, amount of daylight or of fertilizer, or time of planting. This conclusion had already been drawn by Lysenko's predecessor and inspirer, the old horticulturalist Michurin, and in the long first speech in the 1948 debate, which has already been published separately (second title above). Lysenko, now President of the Lenin Academy of Agricultural Sciences and Director of the Institute of Genetics, speaks of this doctrine as Michurinism, and all of his supporters, most of them young men, can be recognized by the slogans which are reiterated in identical form throughout their speeches. "The future belongs to the progressive Soviet Michurinism." These aggressive debaters are ranged against a rather shadowy contingent called "the Mendel-Morgan-Weismann reactionary bourgeois geneticists." These are the persons who first defended the doctrines of modern genetics in the debates of 1936 and 1939. However, when one examines more closely the participants in the 1948 debate, one finds that this last battle in the "genetics" war was fought practically without geneticists on either side. The 47 who supported Lysenko's (Michurin's) theses about the inheritance of direct effects of the environment are a motley assemblage of agronomists, physiologists, biochemists, agricultural engineers, and chiefly plain agricultural politicians, with intellectual stiffening supplied by some professors of philosophy; while the men who did not, at least at first, bind themselves completely to the chariot wheels of Lysenko, i.e., "the geneticists," comprise a statistician (Nemchinov), an endocrinologist (B. M. Zawadowsky), an embryologist (Schmalhausen), two plant breeders (Zhukovsky and Zhebrak), and one unclassified biologist who, however, sat so uncomfortably on the fence that his special competence is unimportant (Polyakov). Only two, Rapoport and Alikhanian, could be called geneticists in in any proper sense, as being persons primarily concerned with the principles of genetics. The chief Soviet geneticists—such as Dubinin, Tschetverikov, Serebrovsky—do not appear at all.

This inequality in the opposing forces and the absence of geneticists was not true in the skirmish of 1936 or the full dress battle of 1939. Then geneticists appeared in force and not only in defense but in attack. That the ranks of one side have dwindled to so few is one way of describing what has happened.

What now was the question at issue in this unequal debate? Ostensibly it was the inheritance of direct effects of the environment, the doctrine of Michurin, carefully dissociated from Lamarckism (for Lamarck was a foreigner) versus Weismannism, which the attackers define as the belief in an immortal and sacrosanct hereditary substance, the germ plasm insulated from all modification by the environment, and thus rendering impossible the inheritance of environmental effects. Actually the question was this: Shall two doctrines, one the "Michurin trend," and the other the "Weismann trend," be permitted to exist and to compete in the Soviet Union? The opposition thought they could, but only Rapoport and Schmalhausen came out wholeheartedly for this position. Brave words were spoken by Zhukovsky in criticism of Lysenko, but in the end, after Lysenko revealed that his address had had the prior approval of the Central Committee of the Communist Party, Zhukovsky, Alikhanian, and Polyakov recanted to remove what traces of heresy still clung to their names. It was not only this act but also the political slogans throughout the speeches and the continued reference to the highest scientific authorities as being Marx, Engels, Lenin, and Stalin which so clearly show that these men are Communists first and scientists second. They would probably say that they are first of all Soviet Citizens with a first duty to the state. This is a choice and an order that may seem both unnecessary and "unnatural" to those who have never, or not yet, faced the hard necessities of life on the margins of subsistence and of national existence in a hostile world. Again we report what seems to be a fact and refrain from judgment.

As we read these pages, some of which sound like excerpts torn from a Chekov comedy, we realize that these men are more than Soviet citizens: they are also Russians. The scene of their struggle is the Soviet Union of 1948, to be sure, but this is one political scene superimposed upon the ancient culture of Russia. Here are still the chiefs and elders making obeisance, but now to Joseph Vissarionovich Stalin; and the tribal gods from whom he derives his authority are Marx and Lenin.

The decision on the question was clear enough. Lysenko and his supporters won a complete victory. Perhaps it would be better to say that they had already won it before the debate was convened to make the triumph public. The winners were the agricultural politicians, but the losers were not merely the handful of geneticists who appeared to defend (and to expose) themselves. Lost also were scientific integrity, freedom of thought and speech, sober detachment and impartiality before the facts of nature, all elements of the soil and climate in which modern science has grown.

There is some internal evidence in these speeches as to why the controversy broke out in the U. S. S. R. and at this particular time, but there is no room in an already over-long review to examine this question. Suffice it to say that the reasons appear to be political and social; they can only be said to be scientific in so far as the whole attack on genetics seems to rest on ignorance, which in some cases appears to be willful ignorance, of the evidence, the methods, and the principles of modern genetics.

L. C. DUNN

THE HUMAN RACE. *A Study in the Nature of Knowledge.*

By Emil Froeschels. Philosophical Library, New York. $3.00. 197 pp. 1947.

This book is a philosopher's approach to the relationship between philosophy and medicine, and is an expansion of lectures given by the author over a period of years in the Medical School of the University of Vienna. The book is in three parts entitled: Congenital Knowledge, Two Different Kinds of Time, and Our Destiny.

In Part I, that dealing with congenital knowledge, Froeschels has considered the knowledge of the infinite in mathematics and in philosophy, the existence of God as a variety of the infinite, and the "unconscious" and its antithesis, the conscious, which he reduces to new terms, namely, "the non-expression-ripe" and "the expression-ripe." He describes the relation of the non-expression-ripe to the expression-ripe in perception, action, understanding, the arts, neuropathological symptoms, witticism, and so on. In these new terms, he approachs the Meyerian term of "more or less conscious" and gets closer to Hartmann's conceptions of the unconscious. He asserts that everything we understand can be understood only as a member of an antithetical pair: finite—infinite, for instance. Just how the material understood as congenital knowledge comes to be such is not clear to this reader.

In Part II there are chapters on Time; Motion and Rest, The Present Tense—Being and Becoming, Concepts and Their Essential Relations to Time; The Will, Causalism, Conditionalism, Similarity; Causalism and Conditionalism in Medicine; Freedom of Choice; Psychogenesis—The Body-Soul-Question; Reason and Will; and Reality and Truth. The most interesting item in this part of the book is his conception of the will as "the prototype of force that makes us feel the causes of change everywhere including those which are called forces in physics, e.g. the force of gravity. . . causality is the projection of our will into the outer world. . . . Since this property of causality, the flow, (of a preceding phenomenon into a following one) belongs to the realm of motion and since a concept of motion does not exist, causality cannot possibly be a form of thinking." He summarizes this by saying: "Causality is a 'category' of our will-power and not a form of our thinking." He insists that the expressions "stronger motives" and "weaker motives" are incorrectly used, and he holds that motives of equal strength are never present within the range of will; in fact, there is not any system of measure within the scope of the will. "It is the sovereignty of the will, the freedom of choice that accounts for the fact that finally one motive is chosen." He looks upon repression in the psychoanalytic sense as an active process, namely, "as a desire not to bring certain conflicts to consciousness. The will may avoid certain concepts and they therefore may not become expression-ripe."

In the final chapter of the book, upon Life After Death, the author states: "The soul which is congenitally endowed with the knowledge of God, of the infinite, and of the universe can hardly be thought of as mortal, because the finite can not have any knowledge of the infinite. Only something that has 'sufficient space for the infinite' can know it." He states that all monotheistic religions insist that man's welfare on earth "should be subordinated to man's communion with God. . . . Our desire for well-being on earth is not the ultimate goal. . . . If the will raises knowledge to expression-ripeness in sovereign freedom, then there is no place for resignation to a determinism or decline. The hope must always remain that men, who are equal participants in the community of infinite knowledge, may become aware of this community, act in accordance with infinite values, and discard the more obvious finite elements whose essence is division and whose effect may be discord."

It expresses something concerning our American concept of medical education that such a series of lectures would be practically unknown in any medical school that the reviewer is aware of. We have become technicians in a very strict sense, and our desire to join others, particularly philosophers, in a discussion of "what it is all about" is at a low ebb. Something of the present sort might very well be considered as binding material in working with the over-all social problem.

WENDELL MUNCIE

NEW DIRECTIONS IN SCIENCE TEACHING. *A Report of a Cooperative Project in Seventeen Secondary Schools with the Bureau of Educational Research in Science Teachers College, Columbia University.*

By Anita Duncan Laton and Samuel Ralph Powers. McGraw-Hill Book Company, New York, Toronto and London. $2.50. xii + 164 pp. 1949.

This book describes in detail a long-term and extensive project aimed at introducing new procedures and emphases in science into the actual science classroom. These new procedures and emphases aim to lead science students "to a clearer understanding of society, of the social function of science, and of their individual needs and interests." The reports of the experiences of teachers and students in the 17 participating schools are of a specific nature, and reveal new methods and new aims by describing actual work in progress rather than by abstract generalizing.

Several "new directions in science teaching" are described, all of which center around the human being and his relation to his world. Studies of the community, studies of young people, studies of current problems, courses emphasizing human development and growth, studies of man's relation to the natural

resources, in particular those of his own region, all these reveal the increased value of science courses when the emphasis is placed on the individual human being and his relation to his world.

One important trend in science teaching is presented in the chapter on New Interdepartmental Courses. Progressive teachers are aware of the impossibility of staying within the rigid limits of one science, if the course is being taught for the sake of the students, and not for the sake of a traditional science. How can any student understand photosynthesis or digestion or any other life process without some knowledge of chemistry and physics? This growing tendency to break through traditional compartments of knowledge to an integration of knowledge from many fields is encouraging and should grow rapidly. *New Directions in Science Teaching* reports on several integrations: 1) Integration of all Subjects in the Ninth Grade; 2) Integration of Science and Social Studies; 3) Integration of American History and Chemistry; 4) Science and English; 5) Core Course on Human Living; and several more, all of which are worth serious study. This book should be of value to all science teachers and supervisors and to school administrators in helping them to plan and direct their science courses into channels which will touch the student's daily living, not only while he is in school but throughout his life.

ELLA THEA SMITH

DIX PRÉLUDES À LA BIOLOGIE. *Sciences et Médecine, Série des Sciences Naturelles.*

By Robert Matthey. F. Rouge & Cie., Lausanne. 225 fr. (paper). 226 pp.; ill. 1945.

The ten topics considered in this series of discourses include the following: heredity; sex determination; twins; parthenogenesis; embryology; vision and orientation in bees; psychology of the vertebrates; psychology of reproduction in birds; the origin and uniqueness of man. These nine subjects are preceded by an introductory essay on biology in general. The purpose in presenting this work was to provide some scientific information to the general reader. As the author acknowledges in his preface, in order to achieve this end he has had to simplify to an extreme. No one versed in any of these fields should be too critical, since it was not written for him.

We do not believe that the mechanisms of heredity are so simple that a non-biologist can absorb and understand them at first glance, but assuming this hurdle leaped, then the essays on linkage and crossing over should prove interesting. The chapter on parthenogenesis is a good one, especially since the author's own cytological work on the orthopteran, *Saga pedo*, forms a large part of the material. Other chapters are on the whole based primarily on the work of other men, e.g., Frisch on bee orientation, Hediger on vertebrate psychology, Heinroth on bird psychology. In the final chapter, Matthey broaches his own ideas on man's relationship to other anthropoids. The point emphasized in this connection is that external differences in morphology are secondary to those of the nervous system, thereby giving rise to a wide hiatus in mental abilities.

HENRI C. SEIBERT

PAGEANT OF LIFE SCIENCE. *Fourth Edition.*

By M. W. de Laubenfels. Prentice-Hall, New York. $5.95; $4.60 (textbook edition). vi + 407 pp.; ill. 1949.

With the present edition, this unusual and eye-catching biology text has graduated from offset reproduction of typewritten copy to standard printing on better paper. The improved contrast from the coated stock and glossy ink has helped many of the illustrations, but some of the photographs show less gain than would have been expected. Careful comparison with the third edition reveals small changes in the text, and added or substituted bibliographic references after the 28 chapters. Warnings about poison ivy are more vigorous, and the discussion on medicine has been extended to include the sulfa drugs as well as penicillin. There is a new chapter on phytophysiology and another on agriculture, with a clear conservation viewpoint. *Neurospora* and the recent South African advances in anthropology have not entered the respective chapters, but a few of the newer concepts achieve a place in this fresh edition. The three final chapters (Paleontology; Anthropology; Philosophy—Evolution, and Some Non-Biological Comments) show the same pronounced bias as in earlier editions. The sequence of, evidence for, and dispute over evolution are presented so briefly and in such argumentative style that students are likely to be led contrary to recent thinking on these subjects. The index has been simplified of its previous decimal notation, and though less precise, will require fewer rereadings of the explanation of symbols for occasional users.

LORUS J. & MARGERY J. MILNE

BIOLOGY: HISTORY AND BIOGRAPHY

THE WORLD AS I SEE IT.

By Albert Einstein; translated by Alan Harris. Philosophical Library, New York. $2.75. xiv + 112 pp. 1949.

This interesting selection of addresses, letters, and writings by Albert Einstein is composed of material that dates for the most part from the period between World War I and the Nazification of Germany. Much of the book is devoted to simple and candid discussions

of politics and pacifism, good and evil, the individual and society, and finally the status of the Jews. The book is the authorized English translation of the volume *Mein Weltbild*. Certain essays on relativity and cognate subjects have been omitted, and a correspondence with the Prussian Academy of Sciences, on the occasion of Einstein's resignation in 1933, is here published for the first time in its authentic and complete form. Although the political material is largely derived from the period after World War I, it is clearly if ironically relevant to the present.

The book should be of wide general interest. Its ideas are not those of an impractical but learned scholar, detached from the general struggle for the high ideals espoused. On the contrary, the author's familiarity with the practical complexities of the problems he deals with has evidently been established by many years of thoughtful concern for peace and the amelioration of the lot of the common man throughout the world.

Einstein speaks as the embodiment of 20th century man's conscience, and his unassuming formulation of clear, uncompromising truth should give courage to all men of good will. The quality of the book can be epitomized in the following excerpts, although they do not do justice to its poetry of spirit, its subtle discernment, its flashes of humor, its wide variety of themes, and its love of justice and reason, which make the reading of this book a great and refreshing experience.

"A hundred times every day I remind myself that my inner and outer life depend on the labours of other men, living and dead, and that I must exert myself in order to give in the same measure as I have received and am still receiving. . . .

"The passions of nationalism have destroyed the community of the intellect. . . . The men of learning have become the chief mouthpieces of national tradition and have lost their sense of an intellectual commonwealth.

"The course of events in the last few years has once more shown us how little we are justified in leaving the struggle against armaments and against the war spirit to the governments. . . . The destiny of civilized humanity depends more than ever on the moral forces it is capable of generating. . . .

"Most objects are gained by gradual steps: for example, the supersession of absolute monarchy by democracy. On the question of disarmament, however, we are concerned with an objective which cannot be reached step by step. . . . People will not disarm step by step, they will disarm at one blow or not at all . . . Disarmament and security are only to be had in combination. The one guarantee of security is an undertaking by all nations to give effect to the decisions of the international authority. . . .

"We cannot despair of humanity, since we are ourselves human beings. . . . It is not the individual spectator's duty merely to wait and criticize. He must serve the cause by all means in his power. The fate of the world will be such as the world deserves."

The whole book cannot, unfortunately, be quoted here, but it can be recommended as imperative reading for every adult who flatters himself on possessing both a heart and a brain, and not simply a vertebral column.

EVELYN HOWARD

ZWISCHEN ANDEN UND ATLANTIK. *Reisen eines Biologen in Südamerika.*

By Hans Krieg. Carl Hanser, München. 24.80 DM. 492 pp. + 35 plates; text ill. 1948.

The author, who is director of the Zoologische Staatssammlung in Munich, belongs to that nowadays all too small group of well-informed, enthusiastic naturalists who can extract from any environment a wealth of new and interesting information. During four trips to South America, lasting together nearly 8 years, he collected chiefly mammals and birds, and studied the wild and domesticated fauna, the human populations, and their relations to each other and to their varied habitats. The valuable scientific results of his material and data have already appeared in numerous technical publications. In the present volume, finished in 1939 but only printed 9 years later, the author has recorded his experiences in and impressions of the subtropical regions of South America in an informal, highly informative, and most readable manner. The many chapters represent actually more or less independent essays on the land and its life, particularly on many different mammals and birds, some reptiles and amphibians, the Indians and other human inhabitants, and on economic and political conditions in Latin America. The 347 admirable drawings and the 4 excellent reproductions of watercolors by the author are proof that Hans Krieg is not only a gifted writer, but also a very talented artist.

This book is a valuable addition to the many older, great works on South America by famous naturalists. Unfortunately it contains only an index of names, and lacks one of subjects in a broader sense.

A. H. SCHULTZ

EXPLORER OF THE HUMAN BRAIN. *The Life of Santiago Ramón y Cajal (1852–1934).*

By Dorothy F. Cannon; with a memoir of Dr. Cajal by Sir Charles Sherrington. Henry Schuman, New York. $4.00. xvi + 303 pp. + 3 plates; text ill. 1949.

The series of biographies of which this volume forms a part presents to the layman the lives, aspirations, and accomplishments of great men of science. In writing of the life of the foremost investigator of the structure of nervous tissues, Dr. Dorothy Cannon finds herself in the interesting position of being the biographer of a

biographically minded scientist. Cajal, perhaps, differed from other histologists of the nervous system in that he engaged in a consuming study of the whole nervous system in all of its complexity, and in an equally intensive effort to describe his exciting new findings to the biological world. Several hundred publications, including his autobiography, came from his pen, but they were all part of the same narrative, the life of the nervous tissue. His flair as a biographer is well described by Sir Charles Sherrington, who developed the basic modern concepts of the physiology of the nervous system with the help of the anatomical foundation largely laid by Cajal. Sherrington remarks, in an introductory memoir of Cajal in this volume: "Listening to him I asked myself how far this capacity for anthropomorphizing might not contribute to his success as an investigator. I never met anyone else in whom it was so marked."

Conspicuous in Cajal's approach to his work is not only a great curiosity and zeal for understanding, and the gift of seeing the whole purpose of his work in the midst of complex details, but also an intense personal motivation linked to an unusually passionate patriotism. Clearly depicted by Dorothy Cannon, within the texture of Cajal's personal development, are his outstanding contributions to the body of science: the development of the concept of the polarity and individuality of nerve cells, the elucidation of many details of the architectural superstructure of neuronal patterns and interneuronal relationships, the original histological techniques, and the development of students who became masters in their own right.

In the phenomenon of greatness, the evaluation of time and place is certainly second only to the capacity of the man. Lacking in this story of a man's contribution to neurology is the historical retrospect which might indicate the soil from which Cajal's rich harvest sprang. In a short biography this defect can readily be excused.

DAVID BODIAN

NATURALISTS OF THE FRONTIER. *Second Edition.* *By Samuel Wood Geiser. Southern Methodist University, Dallas.* $5.00. 296 pp.; ill. 1948.

As this reviewer well knows from his own friends among pioneer naturalists on scientific frontiers in other parts of the world, these factual and sympathetically written biographies reveal the appalling difficulties under which Jacob Boll, Jean Louis Berlandier, Thomas Drummond, Audubon, Louis Cachand Ervendberg, Ferdinand Jakob Lindheimer, Ferdinand Roemer, Charles Wright, Gideon Lincecum, Julien Reverchon, and Gustaf Wilhelm Belgrage struggled to extend the frontiers of knowledge in Texas between 1820 and 1880. These very human documents reveal the frailty as well as the nobility of human nature, for it is on the frontier that such characteristics are more conspicuous. Considering the circumstances, it is no wonder that some of these naturalists did not accomplish much; it is amazing that so many achieved as much as they did. This is a book which cannot be overlooked by anyone interested in the development of science in the southwestern states. In an appendix, the author sets out chapter by chapter the principal sources from which he has drawn his material. He has also presented a relatively long, though admittedly incomplete, list of naturalists and collectors in Texas during the period 1820 to 1880. Included are certain names which he considers scientific hoaxes, and a partial list of the author's own publications on the history of science in early Texas. The makeup and printing of this book are attractive. The big page numbers are excellent, but one could wish for less hidden running heads and a larger general map of Texas, even at the expense of its taking the place of the striking end papers. The use of individual maps to show the activities of the several authors is excellent.

ROBERT L. PENDLETON

THE STORY OF MEDICINE. *By Joseph Garland; illustrated by Erwin H. Austin. Houghton Mifflin Company, Boston.* $2.75. x + 259 pp.; ill. 1949.

The story of man's attempt through the ages to understand, and so to prevent or cure his own bodily ailments is a truly romantic tale, filled with just as much human interest, drama, and suspense as any modern fictional thriller. The added interest and clarity which the author has given the story in this particular volume make it a thoroughly fascinating book. Written in an authoritative, yet simple manner, the work should have a strong appeal for the adolescent or young adult for whom it is primarily intended.

As a history of medicine, the volume is not a mere chronicle of names, dates, and events, but is rather an account of the surging power of awakening knowledge in its struggle against the superstition, the empiricism, the skepticism, and the pure ignorance which surrounded and encumbered the field of medical thought and action for so many centuries of the past. From its beginnings in the mysterious incantations and activities of the prehistoric medicine men, the story of the development of medicine is traced through the ancient civilizations of the world, with descriptions of the contributions of the Egyptians, Syrians, Babylonians, Persians, Hindus, Hebrews, Chinese, Greeks, and Romans, up to the "Dark Ages" when all learning was entombed in the monasteries. With the Renaissance individual thought and action reawakened in the field of medicine, as in many other fields of knowledge and endeavor. Clearly depicted are the tremendous accomplishments in medicine and surgery over the past

one hundred years, following the advent of anesthesia and asepsis. With the present broadened knowledge of medicine and surgery that has resulted from research and clinical experience over the past fifty years, the outlook for the future is so bright as to be beyond our present powers of imagination. With the reduction of deaths from the greatest killers of the past and the consequent aging of the population, new and different medical problems will face our future generations of doctors. With a shifting of emphasis from the curing of disease to the prevention of illness and the maintenance of health, our present generation is seeing a change in the character and responsibility of medical practice. In an age of medical specialization, the author concludes his treatise with a timely salute and a word of sympathetic understanding for the very back-bone of the profession—the general practitioner. The text is provided with an ample supply of line drawings, a bibliography, and an index.

B. Aubrey Schneider

Noah Webster: Letters on Yellow Fever Addressed to Dr. William Currie. *Supplements to the Bulletin of the History of Medicine, Number 9.*

Edited by Henry E. Sigerist, with an introductory essay by Benjamin Spector. The Johns Hopkins Press, Baltimore. $2.00 (paper). vi + 110 pp. + 1 plate. 1947.

No history of medicine in the United States would be complete without paying tribute to the accomplishments of a long and illustrious list of men, who, although they were not physicians, yet made notable contributions to the development of medical thought and practice. Among these men, Noah Webster has earned a place of distinction. Conducting his investigation and writing at a time when the whole medical profession was rigidly bound to the prevailing systems of medical thought and practice, and blinded by them, Webster was deliberate and caustic in his criticism of the profession's inability to grasp new concepts based on carefully collected evidence. He was equally deliberate, yet altruistically earnest, in emphasizing the need for informing the public on matters of public health.

Some 25 letters on Yellow Fever which Webster addressed to Dr. William Currie have been assembled in this volume, and are published for the first time since their original appearance in 1797 in the *New York Commercial Advertiser*. Throughout the letters, one is impressed by Webster's keen ability to collect and analyse facts relating to the specific concepts and theories which he propounded. For example, Letter IV (November 1) opens thus: "To prove that the plague, though infectious, does not depend on specific contagion for propagation, but on accidental and local circumstances, let me call your attention to facts." Webster then proceeds to marshal the evidence relating to the origin of the yellow fever plagues, their spread, and their limitations with regard to northern and southern latitudes, topography, rivers, mountains, and coastlines, as well as to the distribution of populations. By sheer force of incontestible evidence, the writer showed that yellow fever is related to latitude (being more prevalent in the warmer climates); that it is related to topography (being more prevalent in seashore and river lowland regions than in arid or mountainous regions); and that it is not spread, like other contagions, by contact of person to person. These letters are thoroughly enjoyable and enlightening to read, and can well be studied as patterns of investigation and presentation by the epidemiologists of today.

B. Aubrey Schneider

The New York Academy of Medicine: *Its First Hundred Years.*

By Philip Van Ingen. Columbia University Press, New York. $10.00. xii + 573 pp. + 24 plates. 1949.

Through its admirable medical library, the second in the United States, its Bulletin, and its Public Health and educational activities the New York Academy of Medicine, founded in 1847 as an association of 185 New York physicians, has indeed become a "national institution." The growth of the Academy was strong and steady, like that of the nation, the city, and the profession that fostered it. In 1874 it acquired its first home, in 1890 it built a second, and in 1926 it moved into its present luxurious quarters. It is interesting to notice that the latter development was primarily financed by the Carnegie and Rockefeller foundations. In entering this last stage of very extensive activities, the Academy was no longer able to carry on exclusively with elected officers, and has since, like similar organizations, acquired a quite sizable bureaucracy.

Unlike European Academies, the New York Academy was founded primarily not as a scientific body but as a professional combat organization, to fight especially against organized medicine's bugbear of the period, homeopathy. Only gradually, especially since the 1860's, has it grown into its present primarily scientific role. It is consistent with medical developments in the United States in general that during the 19th century the best work presented to the Academy was surgical. In the 1880's the events during the crisis over the Codes of Ethics of the A.M.A. and of the New York State Medical Society convinced the majority of fellows of the Academy that it would be best to keep out of medical politics in the future. In this instance, as in the whole history of the Academy up to 1919, the influence of Abraham Jacobi, the '48er who became

the "father of American pediatrics" and belonged to the Academy for more than 60 years, was strongly felt. Public health is an interest which the Academy has followed without deviation from the very beginning. A survey of the discussions and problems of the 1920's arouses here as elsewhere a melancholic feeling that in some respects we have been turning in circles during the last 30 years.

The conscientious chronicle of Philip Van Ingen contains innumerable details that are of the greatest interest to a medical historian. Its purely descriptive form, which enumerates events in chronological order, is unfortunately such that it raises a doubt whether the book will be much read outside of a rather narrow circle of specialists.

ERWIN H. ACKERKNECHT

READINGS IN THE HISTORY OF PSYCHOLOGY. *The Century Psychology Series.*

Compiled and edited by Wayne Dennis. Appleton-Century-Crofts, New York. $4.75. xii + 587 pp.; ill. 1948.

This compilation of readings in the history of psychology fills a long-standing gap in the library of psychological texts. It is the only such set available and, fortunately, it is a good selection. The volume contains 61 passages; 50 different authors are represented. With the exception of two from Aristotle, the selections cover the period from 1638 to 1930. Eighteen of the passages were originally published in the present century. Although the readings are of general interest, they are perhaps over weighted with materials from the field of general experimental psychology. All in all, this should be a valuable supplementary textbook for courses in historical and systematic psychology.

A. CHAPANIS

A HISTORY OF AGRICULTURE.

By T. Bedford Franklin. G. Bell and Sons, London. 10s. 6d. viii + 239 pp.; ill. 1948.

While this book attempts to cover the history of agriculture from Old Testament times, the most significant, most interesting, and by far the largest part of the book covers the development of farming in Britain. The author comes from an old English rural family and evidently is well acquainted at first-hand with agriculture in England. Not only is his description of the historical development of agriculture in England highly interesting, but it is significant for an adequate understanding of the present plight in which Britain finds herself. The book is well written, beautifully printed and illustrated, and should be read by all Americans interested in the problems of land utilization, particularly those in that part of the United States east of the Mississippi River. The British price is cheap enough so that it should be available here at a reasonable price. Too many British books these days are priced too high for purchase by the average technical reader.

ROBERT L. PENDLETON

ECOLOGY AND NATURAL HISTORY

THE STUDY OF PLANT COMMUNITIES. *An Introduction to Plant Ecology.*

By Henry J. Oosting. W. H. Freeman and Company, San Francisco. $4.50. 389 pp. 1948.

Professor Oosting, of Duke University, writes from a sound background of training, teaching, and research. Like most busy men, he has learned to express himself simply, clearly, and directly. In consequence, he has produced, not merely a learned compilation, but a functional book, of which he might honestly say, "All of which I saw and part of which I was."

The book begins with a brief analysis of the nature of ecology, then considers at some length the nature of the community and the ways of getting at its structure and composition. A third group of chapters deals with the environment, a fourth with the processes of the community, and a final section deals with applied ecology. The illustrations are numerous and excellent, the discussion well balanced, and the references are numerous and good enough to give a generous introduction to the whole subject.

This reviewer has elsewhere (*Ecology*, 30: 109. 1949) indicated a few matters of fundamental theory which deserve more attention than they get. This is actually more of a comment on the current state of ecological thought than a valid criticism of this valuable book. For students well grounded in anatomy and physiology it will serve as an adequate textbook. For others, it might well be combined with the revision of Cowles *Ecology*, or used in conjunction with Daubenmire's *Plants and Environment*.

PAUL B. SEARS

THE SOIL AND THE SEA. *A Symposium.*

By Julian Huxley, Anthony Barnett, Sir John Boyd Orr, Brian Vesey-Fitzgerald, Winifred Brenchley, Richard Clements, Hugh B. Cott, George Smith, J. D. U. Ward, James Gray, J. A. Scott Watson, F. E. le Gros Clark, L. Harrison Matthews, Gordon Haskell, M. K. Schwitzer, David T. Gauld, D. P. Hopkins, C. M. Yonge, and H. C. Long; edited by Trevor I. Williams. Saturn Press, London. 10s. 6d. 242 pp.; ill. 1949.

While the subtitle of this book is "a symposium," actually it appears to be merely a compilation of

articles from popular British magazines by well-known British scientists and writers. While many of the articles are stimulating and contain at least much interesting and at times useful information, there is lacking any sense of that unity which could be expected from the subtitle. The only original article appears to be the introduction by Trevor I. Williams. The other articles and authors are: Science and the Farmer (J. A. Scott Watson); The Scientists' Guide to Global Food (F. E. leGros Clark); Chemical Stimulants for Crops (Richard Clements); Weeds of Cornfields (Winifred E. Brenchley); Chemurgy—New Uses for Farm Crops (M. K. Schwitzer); Seeds and Civilization (Gordon Haskell); Crops without Soil (D. P. Hopkins); Forestry Today (Sir John Boyd Orr); Seeds of the Forest (J. D. U. Ward); The Influence of Man on Marine Life (C. M. Yonge); Whales and Whaling (L. Harrison Matthews); Artificial Fertilisers in Fish Farming (David T. Gauld); Species and Evolution (Julian S. Huxley); Migration of Vertebrate Animals (James Gray); The War against Rodents (Anthony Barnett); Fair Fowl and Foul Fare (Hugh B. Cott); The Senses of Bats (Brian Vesey-Fitzgerald); Moulds and Tropical Warfare (George Smith). One startling suggestion is that the sea should be fertilized in order to get more fish from it for human use. This is the opposite of suggestions of certain conservationists who hope that we can recover from the sea more of the essential elements which we need for fertilizing our land crops!

ROBERT L. PENDLETON

DIAGNOSTIC TECHNIQUES FOR SOILS AND CROPS. *Their Value and Use in Estimating the Fertility Status of Soils and Nutritional Requirements of Crops.*

Edited by Herminie Broedel Kitchen; prepared by Firman E. Bear, Roger H. Bray, Leland F. Burkhart, Jackson B. Hester, Bert A. Krantz, James E. McMurtrey, Jr., Ivan E. Miles, Werner L. Nelson, Michael Peech, J. Fielding Reed, Albert Ulrich and Silvere C. Vandecaveye. The American Potash Institute, Washington, D. C. $2.00. xxiv + 308 pp.; ill. 1948.

Almost anyone concerned with the production of plants or estimating the plant-producing capacity of soils can read this book with profit, at least considerable portions of it. It sets out the real problems and difficulties of endeavoring to estimate even roughly the fertilizer or other needs of any one soil for any one crop. Each section has a lengthy bibliography. Bear has written an excellent historical introduction, giving the history of the understanding of plant nutrition and telling how various researchers have endeavored to estimate the fertilizer needs better. Peech gives a critical review of the chemical methods now in common use for assessing soil fertility. The underlying principles on which the methods are based, and the advantages and disadvantages of the methods, as well as their usefulness and limitations, are pointed out. Bray discusses the correlation of soil tests for crop response without fertilizers and with fertilizer requirements. With references to 14 of his own papers, this is an important statement of the position of the leading soil fertility scientist in Illinois. He concludes that plant tissue tests are the solution to nitrogen control and gives two methods in detail. Miles and Reed describe how the North Carolina soil testing service operates and give many useful practical hints. Hester discusses the operation of an industrial service laboratory for analysing soil and plant samples, namely, that of the department of agricultural research of the Campbell Soup Company. He emphasizes that soil fertility in successful crop production cannot be over-stressed and that quality in the products used is of paramount importance to a processing industry. Krantz, Nelson, and Burkhart discuss the use of plant tissue tests as a tool in agronomic research. They conclude that plant tissue tests are one of the many aids that can be used to determine how to obtain optimum plant performance in any given environment, and that tissue tests should supplement rather than replace other tests and measurements. They describe at length the testing procedure for plants at various stages of growth, and discuss applications and interpretations. Ulrich presents the concepts of critical nutrient levels within the plant, and the theory of "limiting factors." He gives the analytical methods used in his laboratory. Vandecaveye discusses biological methods of determining nutrients in soils, giving very useful comparisons on the lettuce and sunflower between Neubauer's soil-plaque method and Niklas' *Aspergillus niger* method. The laboratory techniques are set out in sufficient detail to enable them to be followed. His comparison of these with other methods is extremely useful. McMurtrey describes the visual symptoms of malnutrition in plants and presents some useful color plates of plants to show the effects of different deficiencies. This chapter includes a key to plant nutrient deficiency symptoms and an extensive review of the literature, element by element, summarizing visual deficiency symptoms of plants, and giving the botanical names of most of them making the review useful internationally. A bibliography of 175 references is incorporated in this review alone. No one who is concerned with crop production, particularly where fertilizers or other soil amendments are used, can afford to be without a copy of this well-edited and beautifully printed book at hand.

ROBERT L. PENDLETON

LARGE WAS OUR BOUNTY: *Natural Resources and the Schools. 1948 Yearbook.*

Association for Supervision and Curriculum Development of the National Education Association, Washington, D. C. $2.50. 216 pp.; ill. 1948.

This is really a thrilling book and striking evidence of the dynamic attitude now taken by leaders of education. Its concern is with the development and use of our natural resources and with what schools are doing to make our use wiser. The chapter headings are: In What Direction Are We Moving?; Why Are We Concerned?; How Has Our Thinking Expanded?; What Principles Shall Guide Us?; What Are Schools Now Doing?; and How May We Move Ahead? An evidence of the openmindedness and progressiveness of the committee preparing this yearbook is the fact that they, professional educators, have dared to use even a little simplified spelling. To many of us the country school teacher typifies conservatism—she is the one who insists upon following the textbook, because it has always been just that way. Not only does this book attempt to show the teachers how to relate students to their particular world but also how they can better lead their communities toward better appreciation of the essential and limited character of natural resources, and hence why and how resources must be conserved. The book is well printed; the illustrations are excellent and to the point. The volume closes with a list of about 10,000 names and addresses of members of the Association.

ROBERT L. PENDLETON

LIMNOLOGICAL ASPECTS OF WATER SUPPLY AND WASTE DISPOSAL. *Publication of the American Association for the Advancement of Science.*

Edited by F. R. Moulton and Florence Hitzel. American Association for the Advancement of Science, Washington, D. C. $3.25 (cloth); $2.75 (paper). vi + 87 pp.; ill. 1949.

This slender volume consists of eight papers by eleven authors, dealing with such subjects as stream pollution, sewage disposal, and the biological effects of algal control. Although the symposium was designed to focus on the common meeting-ground of the sanitary engineer and the hydrobiologist, it is, like all such efforts, spotty and incomplete. The most conspicuous gap is the lack of any discussion of the rationale of using our streams and tidal waters for the disposal of valuable materials which should be returned to the soil. A general statement of the biology of sewage plants would have made a good introduction. The most interesting papers for the biologist are those that deal with stream biota in relation to pollution. While these papers will be of interest and use to those concerned with the general problems of sewage disposal, the price seems a bit high for what is little more than an extended pamphlet.

JOEL W. HEDGPETH

FIELD GUIDE FOR BIRDS, WILD FLOWERS AND NATURE STUDY. *Grosset's Library of Practical Handbooks.*

By Leon A. Hausman. Grosset & Dunlap Publishers, New York. $1.00. xii + 107 pp.; ill. 1948.

Although not intended as a field guide for children, the simplicity of treatment and lack of detailed information places this volume in the category of primers. Since its few pages cover not only the natural history sides of botany and zoology, aquatic as well as terrestrial, but also geology, mineralogy, astronomy, and cloud formation, together with 400 illustrations, a cursory treatment is inevitable. As a consequence, it can scarcely be considered a contribution to our natural history literature.

C. P. SWANSON

THE NATURAL HISTORY OF MOSQUITOES.

By Marston Bates. The Macmillan Company, New York. $5.00. xvi + 379 pp. + 16 plates; text ill. 1949.

Marston Bates has assigned himself a very difficult task —to bring together in one volume an account of the natural history of nearly 2000 species of mosquitoes, widely distributed throughout the world. When one recalls the vast and complicated literature dealing with mosquito biology, bionomica, distribution, taxonomy, etc., the author is to be congratulated for his bravery in undertaking such a work. In the introductory chapter, he has outlined the problems before him and defined the objectives he had in mind. He has adopted the term Natural History "in order to emphasize a broad approach to a limited group of animals." He defines it as not only including the somewhat modern science of Ecology, but also the analytical work of the laboratory—in other words it "includes both the field and laboratory study of living organisms." "Field observations of the behavior of single organisms or of the interrelations of communities of organisms can hardly be interpreted without laboratory analysis under conditions where experimental techniques can be applied," states the author. In this book the author has attempted to restrict himself to the disciplines of ecology and physiology, though throughout the emphasis is mainly on behavior.

It is not possible to review adequately such a compendium of information as is gathered here from published works and the extensive experiences of the author in the field of mosquito biology. A brief listing of the chapters will give the best idea of its contents and the arrangement of the subject matter. The author begins his analysis with a study of the adult mosquito, devoting Chapters II to V to the various aspects of adult activities, such as environment, survival and dispersion, sexual behavior, and food habits.

Chapters VI and VII are devoted to the discussion of egg development in the female and the characteristic oviposition habits of mosquitoes in general, with brief accounts of the various types of eggs. Chapters VIII to XI are concerned with the larval stage, and stress such topics as environment, physiology and behavior, the biological characteristics of aquatic life, and finally, an attempt to classify larval habitats. The pupal stage is treated very briefly in Chapter XII, and the reviewer could wish a more detailed account had been given of the tremendous physiological activities which transform an aquatic larva into a delicate, wonderful mosquito within the space of two or more days. Chapters XIII to XV deal with the enemies of mosquitoes, and their relation to disease transmission to man or other animals (as transmission of viruses and plasmodia). In Chapter XVI, the author treads the delicate ground of the species problem and tries his hand at a solution of the mechanics of speciation, only to land, like most experts on speciation, in the doldrums of conjecture. In Chapter XVII there is a very sane and useful discussion of mosquito classification wherein the author, like the reviewer, deplores the vast number of described species that have had to be sunk into synonymy. Unfortunately, a good many of the so-called new species described within the past twenty years will probably have to be treated in the same manner. It would be well for our younger taxonomists to read and digest this chapter and to devote more of their energies to the study of Natural History, as defined by Bates.

There follow a discussion of the faunal distribution of mosquitoes, an account of the methods of mosquito study, and a welcome chapter on mosquito research. The author closes with a list of the various species of mosquitoes (201 species) mentioned in the text, an excellent bibliography, and an index.

Though the reviewer might point out some faults of omission or certain doubtful conclusions, it does not seem that such criticism would detract from the very valuable contributions of this work. The natural history of our northern mosquitoes of North America is treated very lightly, as might be expected, since the author's main research has been with anophelines and tropical species of mosquitoes. His viewpoint of the so-called *maculipennis* group of North America is that adopted by Aitken (1945), although Vargas and the reviewer have pointed out several times that the so-called *occidentalis* species of the East is a distinct species, both on morphological grounds and habits. Unfortunately, we have no authoritative distributional studies of the eastern species (*Anopheles earlei* Vargas) except that of the reviewer and that study extends west only to Michigan.

This work of Marston Bates should indeed be in the hands of all workers concerned with mosquito biology. That taxonomists should beware of loading the literature with new species about which little or nothing is known of the biology is a sound conclusion of the author.

ROBERT MATHESON

THE BEE HUNTER.

By George Harold Edgell. Harvard University Press Cambridge. $2.50 49 pp.; ill. 1949.

As a successful bee hunter of fifty years' experience, G. H. Edgell, Director of Boston's Museum of Fine Arts, at length became sufficiently irritated with printed accounts of trailing wild bees to their tree hives that he drew together the present treatise. In some eleven thousand words he tells in detail and anecdote how to be successful at the art—with expert hunting, from forty-three minutes up to two years being needed to locate an individual bee tree! The "ostensible object is honey," but "it is the least of your rewards. The reward is when, after hours or days of trial and error, your eye catches the flash of wings in the tree and once more you are able to say checkmate in one of the most difficult, complicated, and fascinating games in the world."

The brevity of this informal, amusing lecture somehow brought to mind Ellis Parker Butler's *Pigs is Pigs*. Our copy of the latter is about the same physical size, also cloth bound—and cost us 25¢. Ten times that price seems high for three times the wordage. At $1.00, the art that Director Edgell extolls might have found more followers.

LORUS J. & MARGERY J. MILNE

LIFE HISTORIES OF NORTH AMERICAN THRUSHES, KINGLETS, AND THEIR ALLIES. *Order Passeriformes, Smithsonian Institution, United States National Museum, Bulletin 196.*

By Arthur Cleveland Bent. Smithsonian Institution, Washington, D. C. $1.50 (paper). viii + 454 pp. + 51 plates. 1949.

This seventeenth volume in the series of life histories of North American birds includes two families, that of the thrushes (robin, bluebird, wheatear, wood thrush, etc.) and that of the kinglets (gnatcatchers and kinglets). The same method of treatment as in previous volumes is followed. One interesting feature of the present number is the inclusion of many species not commonly considered as North American birds, but appearing on the list because they are found, accidentally or otherwise, in such remote areas as Alaska and Greenland. Thus the Iceland red-winged thrush, the fieldfare, the European blackbird, the European

wheatear, the red-spotted bluethroat, and Middendorff's grasshopper-warbler are included. These birds, however foreign they may appear to be, are accorded full treatment and are provided with the usual amount of information. For those not familiar with Bent's volumes, this information consists of: spring, nesting, eggs, incubation, young, plumages (of the young), food, behavior, voice, field marks, enemies, fall, winter, breeding range, winter range, migration, casual records, and egg dates. Some species have additional information about interesting banding records. The usual photographs and bibliography are present.

HENRI C. SEIBERT

MAINE BIRDS. *Bulletin of the Museum of Comparative Zoölogy at Harvard College, Volume 102.*

By Ralph S. Palmer; based largely on data gathered by Arthur Herbert Norton. Museum of Comparative Zoölogy, Cambridge. $5.00. 656 pp.; maps. 1949.

Back in 1908 Ora Knight published the *Birds of Maine.* Since that date new information on Maine birds has accumulated in the literature, but hardly enough to have justified the present report had it not been for A. H. Norton, who, on his own, formed a file of some 17,500 cards containing 60,000 entries relating to Maine birds. Norton was so busy during his lifetime that he never contemplated publishing his material, but fortunately bequeathed the file to Palmer. The latter has incorporated these data in the present publication. To this have been added his own observations plus information gathered from a careful survey of the literature. As a result, not only has the ornithology of Maine been brought up to date, but many of the records have been evaluated as to their reliability, and many of the old errors exposed. A recapitulation indicates that 339 species and 22 additional subspecies are authentic birds of the state. This excludes hypothetical, introduced, extirpated, or erroneously recorded species.

No attempt has been made to offer an historical background of ornithological work in the state, nor any discussion of its physical or vegetational features. For each species the subject matter is subdivided into a) general status, b) spring, c) fall migration, d) flight years or incursions, d) breeding, f) winter status, g) ecology, h) remarks. In the last subdivision there are often interesting comments on population changes since Knight's time. (Naturally some species do not possess all these categories.) There is an index, along with three maps and a very extensive and apparently complete bibliography. Although there are large areas left in Maine where the bird life has never been studied, at least one can feel assured that the knowledge concerning what is known has been included in this report. Future workers in Maine can be thankful that a dependable reference is now available.

HENRI C. SEIBERT

A STUDY OF A GROUP OF PENGUINS OF KNOWN AGE. *Biological Monographs, Number 1.*

By L. E. Richdale. Otago Daily Times and Witness Newspapers Company, Dunedin, New Zealand. 12s. 6d. (paper). viii + 88 pp. + 7 plates; text ill. 1949.

Because of their appealing and amusing appearance, penguins are well known to visitors of zoological gardens, but not well enough to the ornithologist. This latter deficiency has been reduced in great part by the persistent labors of the present writer, a resident of New Zealand where some of the penguins live. This particular monograph is based on 12 years observation of yellow-eyed penguins which were banded as nestlings or juveniles, and whose exact age was known. The writer succeeded in banding 460 young, and the data on these birds provide considerable information about the breeding and related behavior of this species.

It was found that there is a strong tendency for breeding birds to return to the same breeding place. Males tend to mate with females younger than themselves, and fertility among young birds, especially the males, is low. Eggs of two-year old females are lighter and narrower than those of three-year olds, which in turn are lighter and narrower than those of four-year olds, the maximum weight and length being attained in the fourth and fifth years. Clutch size is also smaller in younger birds. A tendency toward adolescent sterility was noted, since, out of 76 two-year old females, 48 per cent did not lay, 7 per cent did not complete incubation, and only 34 per cent of the eggs laid hatched. Among three-year old females laying for the first time, 67 per cent of the eggs laid hatched; among three-year olds laying for the second year, 83 per cent hatched; and among eggs laid by four-year olds, 91 per cent hatched. Only one case of inbreeding was discovered—two birds from the same clutch mated and reared chicks. Unemployed birds (here defined as a bird without eggs or chicks at a time when other birds are so employed; such a bird may earlier have possessed eggs or chicks, and hence differs from a non-breeder) from a large proportion of the penguin population, up to 61 per cent of the total adults.

These are but some of the results obtained in this valuable study. The pages are replete with tables (56 in all), each of which is ably explained. A general discussion at the end compares the breeding biology of the penguin with that of other species for which there is comparable information. Although limited in its scope to those penguins of known age, the amount of information extracted from the data speaks highly of the

author's devotion through long hours in the field and of his astute powers of observation.

HENRI C. SEIBERT

THE BIRDS OF CONCORD. *A Study in Population Trends. New England Bird Studies, II.*

By Ludlow Griscom. Harvard University Press, Cambridge. $5.00. xii + 340 pp. + 16 plates; text ill. 1949.

Here is something more than a mere compilation of a bird list from a selected region. Although 287 species and subspecies are recorded as having occurred in Concord, Assabat, and Sudbury River valleys of Massachusetts, this amazing total for a northeastern state is not the primary reason behind the publication of this book. Rather, it is a valuable comparison of the bird life, back to the 1860's, with that of today. Nowhere else has an avian population been analysed for a period extending some 80 years. This feat was made possible by the voluminous notes of William Brewster, whom the author considers to have been a field ornithologist without peer. Since Brewster's time others have worked the region regularly, with the result that a continuous record is available.

The introduction gives a detailed account of the source material upon which the succeeding discussion is based. The latter is divided into Part I, Population Trends, and Part II, Birds of the Concord Region. Part I considers basic factors, such as geology, climate, vegetation, and the effects of civilization. It is concluded that static populations for any length of time are impossible because of major and minor climatic cycles and attendant shifts of vegetation and food supply. Human civilization is considered a factor as important as any other except major climatic changes. Declines and increases are discussed next, and here the myth of periodic fluctuations is further punctured; the periodicity is merely a mathematical average which does not correspond with the facts. Crashes are due to a complicated pattern of various causes, from which the species affected normally recovers. Only when human interference is an added agent does the population decline last for a long period. The erratic status of many species is described in detail and analysed for the causes behind the shifts. Some are inexplicable at present, e.g., the decline of the indigo bunting and nighthawk. Others can be correlated with changes in vegetation or habitat, or to reduced hunting (egret) or loss of food supply (brant). The severe hurricane of 1938 destroyed most of the large trees, and its effect on tree-hole nesting birds is still being felt. Griscom feels that these are all minor or temporary changes and that, because of the adaptability of birds in general, the populations will return as soon as the unfavorable circumstances are ameliorated, provided of course, that somewhere there is an overflow population to provide a nucleus from which the species can spread.

The second part is concerned mostly with the present status of the bird fauna and includes statistical data on breeding birds. The systematic list follows. A bibliography, index, and photographs of birds are included.

This volume is the second in the series (*Birds of Nantucket* being the first). The discussion in the present volume is of a more general nature and is applicable to birds everywhere. Anyone interested in animal populations should read this report carefully. It affords an intelligent and reasonable interpretation of population dynamics that is probably applicable to many other groups of animals besides birds. The reader will thereafter be cautious in the use of terms like "periodic cycles," "disasters," "booms," or "abundant." It has been clearly demonstrated in the 80 years of this record that a species may increase or decrease twice, and even three times, so that a fluctuating population is *the* normal population, whatever the causes underlying that fluctuation may be. It had best be borne continually in mind, therefore, that there is no set base-line or norm for making comparisons.

HENRI C. SEIBERT

MAMMALS OF LAKE TAHOE.

By Robert T. Orr; illustrated by George and Patritia Mattson. California Academy of Sciences, San Francisco. $4.00. xii + 127 pp.; ill. 1949.

This book, dedicated to the memory of the naturalist James Moffitt, realizes a prolonged ambition of the author to write about an area that he has known for many years. The realization of the wish has produced a fine book that satisfies its purpose not only of being valuable to the general reader who is interested in the Lake Tahoe area, but of being scientifically correct as well.

The life histories of the fifty-three Tahoe mammals included present a description of each animal, its general and local distribution, and pertinent information regarding its habits. Each animal is represented by an excellent, life-like sketch, accompanied in some instances by a figure of its tracks.

In addition to the life histories, special sections of the book give a brief history of the Tahoe area, a description of its general physical and ecological features, an explanation of the methods used in classifying mammals in general, and a very workable, convenient key to the mammals of the lake region. A topographical map of the Tahoe area is to be found inside the back cover; and a glossary and list of references complete a book that the reviewer recommends without reservation to all readers interested in the subject.

JOHN CUSHING

ANNALES BIOLOGIQUES. *Conseil Permanent International Pour l'Exploration de la Mer. Volume IV.*
Edited by H. Blegvad; with the assistance of Aa. J. C. Jensen. Andr. Fred. Høst & Fils, Copenhague. Kr. 18.00 (paper). 152 pp.; ill. 1947.

EVOLUTION

PRÉCIS DES DÉCOUVERTES SOMIOLOGIQUES.
By C. S. Rafinesque. Peter Smith, New York. $4.00. iv + 56 pp. [1814]; 1948.

"A reprint of one of Rafinesque's earlier attempts to establish a system of classification for both animals and plants." His feeling was for a natural rather than an artificial system and, as he believed that races, varieties, and even species were evolving rapidly, he tended to split his taxonomic groups as he thought nature was doing. In this work he described 110 new species of animals and 79 new species of plants. His descriptions were characteristically inconsequential and he was successfully ignored by his contemporaries. His work, however, must now be considered seriously, thanks primarily to the efforts of E. D. Merrill, who wrote a brief foreword to this reprint. As more of Rafinesque's rare works are made available in facsimile, it becomes easier for modern taxonomists to do justice to his remarkable, if erratic, contributions.

CONWAY ZIRKLE

LES HOMMES FOSSILES. *Élèments de Paléontologie Humaine. Third Edition.*
By Marcellin Boule; revised by Henri V. Vallois. Masson et Cie., Paris. 1500 fr. (paper). xii + 587 pp.; ill. 1946.

The last previous edition of Marcellin Boule's well-known and valuable treatise on human paleontology appeared in 1923. The interval of 23 years has witnessed the discovery of a great many important primate fossils, both human and otherwise, notably in China, Java, and Africa. The consideration of this material has greatly enlarged the text. Unfortunately, Boule did not live to complete this new revision, having died in 1942. It is fortunate, however, that the task of completion passed into the able hands of Henri Vallois, another eminent French student of fossil man.

The book, however, remains that of Boule and is not at all of Vallois. For the latter has faithfully followed his predecessor's arrangement and presentation of material, and one still finds Boule's old interpretations throughout. That Vallois does not always agree with Boule is evident from the preface written by the former —thus, for example, he speaks of the fossil men of Mount Carmel and Kafzeh as forms intermediate between Neanderthal man and *Homo sapiens*, and of Solo man as a type intermediate between *Pithecanthropus* and Neanderthal man. In this he is in agreement with the late Franz Weidenreich. The text, however presents the old conclusions of Boule—that *Pithecanthropus* and Neanderthal man are the terminal representatives of distinct and extinct branches of the hominid stem. It remains for the future to determine which of these interpretations is nearer to the truth. A case can be made out for both.

As for the Australopithecines, Boule has not accepted the verdict of their discoverers that they are directly ancestral to man. He regarded this declaration as premature, and was also skeptical of the conclusion that these animals were erect bipeds. Although he regarded the Australopithecines as true anthropoid apes, he admitted that they are the most manlike yet discovered, being in certain characters intermediate between the Dryopithecines and modern man.

This edition represents Marcellin Boule's last will and testament, and it will be duly valued as such. As already noted, Vallois appears to have recognized this and consequently has resisted the temptation to add post mortem codicils. That he saw fit to complete the revision essentially as Boule would have done, the reviewer for one is grateful. But he would also be grateful for a yet newer edition, or perhaps a separate work, in which Vallois will permit himself the full expression of his own views.

WILLIAM L. STRAUS, JR.

A NEW THEORY OF HUMAN EVOLUTION.
By Sir Arthur Keith. Philosophical Library, New York. $4.75. x + 451 pp. 1949.

Sir Arthur Keith, the author of *A New Theory of Human Evolution*, has long been distinguished as an anatomist and physical anthropologist. He has contributed prolifically and substantially in both these categories, and he has intrenched his authority by the success of his charming popularizations. Now in his 80's, he has once more given to the public a summation and revision of his ideas on the origin, evolution, and differentiation of mankind, subjects on which he has frequently written in the past.

It is impossible in a short review to set forth all the details of Sir Arthur's hypothetical edifice or to examine extensively the ramifications of even some of his leading ideas. I must, therefore, content myself with a summary exposition of his main theses and a brief appraisal of their validity. In so far as human evolution is concerned, Sir Arthur has combined current concepts on the significance of isolation and territoriality with his own version of psychological instincts deeply rooted in human nature. He envisages as a necessary condition in the primal (pre-agricultural) stage of human evolution a "myriad" of small in-

breeding population units, isolated genetically, fixed in space over very long periods of time, bound internally by a "consciousness of kind" and fiercely competitive with adjoining groups. The psychological "bias" essential to maintain such conditions favorable for evolution is developed at great length and is ramified into morals (codes of amity and of enmity), patriotism, loyalty, leadership, allegiance, cooperativeness, hate, enmity, cruelty, resentment, and revenge. These psychological factors are regarded as basic qualities with which emergent man was equipped and which served an evolutionary purpose by isolating the original breeding groups from one another and thereby allowed superiority of genetic endowment to survive intact and to permit favorable mutations to be preserved and dispersed rapidly within the group. The psychological aspects are especially stressed, since they are used subsequently to account for various phases of race.

This conception, compounded in detail of sound observation and undemonstrated assumption, is far from being completely convincing. If one goes to the same sources that served Sir Arthur, it is possible to argue that isolation was not as generally characteristic of these small primal groups as he finds necessary for his hypothesis. The absorption of the women of a defeated group, wife-stealing from neighboring bands, slavery, and the exchange of women for political purposes are widespread among the primitive folk who also provide Sir Arthur with his contrary illustrations. Moreover, the distribution of gene frequencies strongly suggests a long history of interbreeding as well as inbreeding. The elaborate psychological apparatus which is developed here as an integral part of the mechanism that controls human evolution requires far more support before one can accept it entirely despite the cogency of some of its elements.

In the sections that deal with the fossil record of man's evolution, Sir Arthur has made a number of radical revisions of his earlier views. He considers Africa as the cradle of the humanoid stock, which he now thinks became differentiated from the anthropoid stem mainly by a process of foetalization. He regards the Dartians or Australopithicinae as the earliest forerunners of man and conceives of them as spreading throughout the Old World and subsequently undergoing local developments which have led to distinct geographic races of mankind. These basic geographic subdivisions are Caucasian, Sinasian, Indoasian, African, and Australasian. Curiously, however, he still clings to Piltdown Man. But since he has difficulty in deriving him from the Dartian base, he assumes that this fossil type of man had an origin from an orang-like stock, an assumption which has the aspect of a deus ex machina.

The final portion of the book is devoted to the origin of modern races, and the role of nationalism in race making. Present-day nationalism is seen as an outgrowth of the original small breeding bands, and as a focus for the same psychological characteristics that governed human evolution in the past. In this view, then, nations are the modern mechanisms by which evolution is advanced and races are created. As in the earlier sections, assumption is built upon assumption with bewildering ease, and contradictions plague the reader. I found, for example, that "race" was used in a variety of ways. When the author attempts to distinguish his concept of race (described as "passionate") from the conventional one corresponding to the generally accepted systematic usage, he produces a difference without a meaning. At one point, the Scots are described as a race distinct from other groups in the British Isles, yet elsewhere he admits that he cannot distinguish them physically from other Britons! Although inbreeding is a cornerstone of his conception, Sir Arthur himself produces from Scotch as well as from other national, and consequently, in his view, racial history, abundant evidence to prove that modern European nations are conglomerations of various strains revealing a vast amount of interbreeding. It is distinctly curious that the role of interbreeding should, therefore, have been so carefully ignored by him as a significant factor in human evolution, and in the genesis of racial differentiation.

HARRY L. SHAPIRO

STRATIGRAPHY AND FAUNA OF THE AGUA SALADA GROUP, STATE OF FALCÓN, VENEZUELA. *The Geological Society of America Memoir 32.*

By H. H. Renz. The Geological Society of America, New York. $2.75. x + 219 pp. + 12 plates + 1 chart; text ill. 1948.

The fauna described is composed entirely of smaller (that is, ordinary) foraminifera of late Tertiary age, which are beautifully illustrated by pen-and-ink drawings, variously magnified from × 22.5 to × 49. In the taxonomic treatment Cushman's classification is followed, though genera are arranged in alphabetical order, and only in the ecologic treatment of geologically different faunules has Cushman's classification in families been followed. Out of 239 described and catalogued foraminiferans 4 are new, while 55 other species and varieties were previously described as new from the same localities by Cushman and the author.

Whenever more than one specimen of a species is illustrated, considerable variability of most species is at once evident, and thus a critical reader interested in the Foraminifera gains a broader mental concept of the species surpassing the elegant sketches of the specimen selected to typify them. The most complete data on the variability of the species are thus given for *Liebusella pazonensis*, *Marginulinopsis basispinosus*, *Robulus wallacei*, *R. suteri*, *R. nuttalli*, *Valvulina flexilis*, and other species which Cushman

and Renz themselves established among the local fossils.

No consideration is given to dimorphism in any of the descriptions, and hence in this respect the work is behind the new trend in the biologic treatment of fossil foraminifera, a trend which is gradually gaining momentum. Aside from this, Renz's work has many good points. Information and discussion concerning ecologic, stratigraphic, and geographic aspects of each species are perhaps the most commendable and useful parts of the publication. The author rightfully emphasizes the necessity of an ecological approach in the comparative study of fossil and living foraminiferans, and he himself utilizes skilfully the available empirical and generalized data of foraminiferal (and other) ecology in modern seas.

M. K. ELIAS

GENETICS AND CYTOLOGY

GENETICS IN SWEDISH FORESTRY PRACTICE. *By Bertil Lindquist. Svenska Skogsvardsforeningens Forlag, Stockholm; The Chronica Botanica Company, Waltham, Massachusetts.* $3.50 (paper). 173 pp.; ill. 1948.

The application of genetic principles in forestry practice has made remarkable progress in Sweden during the past decade. This accomplishment is traceable in large measure to a unity of purpose resulting from a more or less amicable truce declared between the environmentalists, that is to say, the classical silviculturists, and the geneticists. To the advantage of Swedish forestry practice these opposing factions early realized that, quite as much as the organisms they discussed, they were in fact mutually interdependent and that in the broad sense their arguments attributing superior roles to the environment or to the genotype were meaningless.

It may be readily appreciated that the logical path of approach in a forest-tree improvement program is to take immediate steps to preserve from destruction the best of the wild extant genotypes in various ecotypic zones. With such gene reservoirs established, current local planting demands may be supplied with what may at least be considered to be the best of the wild stock available. In addition, and what is of greater ultimate importance, the perpetuation of such desirable gene combinations for future recombinations in breeding studies may be assured. It is in this initial phase of the application of genetic principles to forestry practice that Lindquist has been most active, and it is with this that his book is primarily concerned.

The numerous special problems introduced in tree breeding programs, due to the large unit size of the material involved, the long time between sexual and vegetative maturity of succeeding generations, and the consequent necessity for comparatively long-term progeny tests, have been adequately described by the author. It is indeed these very problems which have stimulated the intensive application of the idea that it is genetically and economically good sense to utilize phenotypically élite parental trees and stands as current seed sources and breeding stock while their genotypes are at the same time being assessed by long-term progeny tests.

Lindquist's discussions of the role of genetics in silviculture are tempered by reasonable and justifiable claims for its possible contributions. Silviculturists will be pleased to read that: "(one should) . . . not let the thought of heredity obscure the fact that environmental conditions generally are and will be the dominant factors for the development of high-grade lumber in our forests."

The book is well organized, and the material is presented in a non-technical manner designed to appeal to the forester who may be unfamiliar with genetic terminology. Numerous excellent half-tone photographs have been used to advantage. These are, in some instances, more provocative than the text. It is to be regretted that specific citations to the literature have not been made, although the contributions of various investigators are in a general way often mentioned.

The realistic approach of the Swedes to forest-tree genetics problems is especially worthy of note to American foresters; and if this book accomplished nothing more than further to encourage American silvicultural thought to recognize the possibilities of genetic variability below the level of the species in our own trees, it will have accomplished a most worthwhile objective.

SCOTT S. PAULEY

HAEMOFILI I DANMARK. *En Klinisk, Haematologisk og Arvebiologisk Undersøgelse af 63 Haemofilislaegter. With an English Summary. Opera ex Domo Biologiae Hereditariae Humanae Universitatis Hafniensis. Volume 6.*

By Mogens Andreassen. Ejnar Munksgaard, Copenhagen. Kr. 10.—(paper). 168 pp.; ill. 1943.

The author has reported here the results of a comprehensive study of the genetics of hemophilia as seen in Denmark. The clinical and laboratory bases for the diagnosis of hemophilia are discussed in a manner that gives confidence in the validity of the cases the author presents. By means of widespread medical inquiry, as complete a roster as possible was established of all cases of hemophilia which had occurred in Denmark in the immediate past. Information was obtained concerning a total of 205 hemophiliacs in 63 different families; 81 of the hemophiliacs were living at the time of the inquiry. The average age at death of hemo-

philiacs was estimated to be 18 years, about one-third that of normal males. The evidence for the sex-linked inheritance of hemophilia is discussed. In particular, it is shown that in this material among the male children of women who should be heterozygous for the hemophilia gene because their fathers had the disease, there are 21 normal and 18 hemophilic sons, excellent agreement with the expected 1:1 ratio. The frequency of hemophilia in the Danish population is estimated to be 0.00013. The fecundity of hemophiliacs is placed at 0.57 that of normal. From the foregoing figures the average frequency of mutation for hemophilia is estimated at 0.000019 per chromosome per generation. The weakest spot in this calculation is the estimate of the mean fertility of hemophiliacs, but even if some revision of this is made, the order of magnitude of the mutation rate will probably not be altered. The author found that 30 our of 31 mothers of hemophiliacs showed a definite prolongation of coagulation time, an extremely significant demonstration both from the standpoint of further studies of the population dynamics of hemophilia and also because of the practical problem of predicting where hemophilia may be expected to occur in any kindred. This is an excellent study.

JAMES V. NEEL

THE ETIOLOGY OF DEAF-MUTISM, *With Special Reference to Heredity. Opera Ex Domo Biologiae Hereditariae Humanae Universitatis Hafniensis. Volume 8.* *By Harold Lindenov. Ejnar Munksgaard, Copenhagen.* Kr. 25.00 (paper.). 268 pp. 1945.

This monograph reports the results of a large-scale investigation into the heredity of deaf-mutism. The introductory chapters are devoted to a discussion of the etiology and differential diagnosis of acquired and "idiopathic" deaf-mutism, and an extensive review of the voluminous past work on the genetics of the "idiopathic" form of the disease. The author's own material is composed of (1) 32 families in which deaf-mutes occurred, and in which as many members as possible of the families were studied by the author personally, and (2) 480 unselected deaf-mutes who were examined and from whom a family history was obtained, but with no examination of relatives of the propositi. No objective clinical finding which would serve as a certain means of differentiating between "idiopathic" and acquired deaf-mutism could be discovered. A careful history is thus the most reliable means of making the differentiation, and even this is not infrequently inadequate. No physical peculiarities were discovered that distinguish the deaf from the hearing members of families. It is estimated that 45.5% of deaf-mutism in Denmark is "idiopathic" and probably hereditary, the reminder being acquired. There is no apparent sex predisposition to the disease. The hereditary disease appears to be of at least two types, a minority representing a "heredolabyrinthic deaf-mutism," and a majority representing an undifferentiated type which may be genetically complex (see below). Consanguinity of the parents was significantly increased in the parentage of the "idiopathic" deaf-mutes (9.7%) as compared with the acquired deaf-mutes (2.2%) and the normal population (2.1%). The author's own material is insufficient to determine the mode of heredity of the heredolabyrinthic type; in the literature it is usually described as a dominant. The familial distribution of the remaining idiopathic cases is consistent with simple recessivity. It was felt that the present data provide evidence for a familial predisposition to acquired deaf-mutism. The reviewer would hesitate to accept this finding as having a genetic significance. Retinitis pigmentosa was so frequently present in deaf-mutes that the association cannot be ascribed to chance, and is thought to be due to a particular recessive gene responsible for both deafness and retinal disease. There are thus probably at least three genetic types of "idiopathic" deaf-mutism. Possible eugenic procedures are discussed. This is a sound and thorough piece of work, documented in the extensive manner we have come to expect of publications from the University Institute of Human Genetics of Denmark.

JAMES V. NEEL

GENERAL AND SYSTEMATIC BOTANY

ALLGEMEINE BOTANIK. *Ein Lehrbuch Auf Vergleichend-Biologischer Grundlage.* *By Phil. Wilhelm Troll. Ferdinand Enke, Stuttgart.* DM 60.00 (cloth); 56.00 (paper). xviii + 749 pp.; ill. 1948.

For the beginner facing the exciting challenge of a career in botany, and confronted, too, with the double necessity of mastering an important foreign language and of acquiring the basic principles of his science, there is no better prescription than the persistent reading of a good German text. For many decades there was scarcely a question as to what this should be. The Bonn textbook, fathered by Strasburger and amplified by his later collaborators, had no rivals.

The modernization of American botanical teaching began with Charles E. Bessey's frank adaptation of Sachs, and was furthered in original fashion by the Chicago textbook. It is not generally known that one of the best of our current textbooks was the fruit of a long ambition to produce "an American Strasburger."

The motif of the Bonn text has been from the particular to the general, from the component to the organism. This is the method of research. It is the path of evolution. It seems eminently logical, if one

accepts the Cell Theory as meaning that the whole is the product of its parts.

Meanwhile, however, two powerful influences have entered the scene. One is the Organismal Doctrine. The other is the modern psychology of learning, which insists on the importance of proceeding from the known and familiar to the unknown. American textbooks have for some time adjusted themselves to these new viewpoints. But the best of them, as sheer didactic, visual, and bookmaking performances, have never excelled and rarely approached the best of the continental works.

Now comes Troll's "General Botany," which appears to have, on a first reading, the excellence of the Bonn textbook, although a more restricted coverage, and which begins with the plant as a whole, later developing the details of its structure and behavior. I can imagine no more profitable possession for the beginning specialist, although I should not discourage him from having the most recent edition of Strasburger (mine is the 22nd) on his shelf as well.

PAUL B. SEARS

BOTANY OF THE CANADIAN EASTERN ARCTIC. *Part Two. Thallophyta and Bryophyta. National Museum of Canada, Bulletin Number 97, Biological Series Number 26.*

Compiled and edited by Nicholas Polunin. National Museum of Canada, Mines and Geology Branch, Department of Mines and Resources, Ottawa. $1.00 (paper). vi + 573 pp. + 1 map; text ill. 1947.

This volume of over 500 pages is an authoritative account of the algae, fungi, lichens, mosses, and hepatics, based upon reliable published and unpublished reports and from recent collections of an immense region of the Canadian Arctic. The work on the various groups has all been done by well-known experts in their fields, and we have as a result a fairly complete flora, if not of the vast Canadian Eastern Arctic, comprising as it does nearly a million square miles, yet, as the General Editor, Polunin, has aptly pointed out, of the few areas from which collections have been made. In other words, we know considerably more now about the kinds of Thallophyta and Bryophyta and their distribution within the region than ever before.

The chapter on the algae, exclusive of diatoms and marine phytoplankton, was prepared by Roy M. Whelden. Here are listed 108 of the Cyanophyceae, 1 of the Heterokontae, 3 of the Chrysophyceae, 247 of the Chlorophyceae (184 of which are desmids), 3 of the Dinophyceae, 12 of the Phaeophyceae, and 9 of the Rhodophyceae. Included among these forms, which were predominantly from fresh water, are many new records of occurrence both for Canada and for the whole of North America. Each species name is accompanied by a citation, pertinent synonyms, comments, and general and Eastern Arctic occurrence. This same format is followed throughout the volume. Like all others, the chapter is prefaced by a general account of previous work which has been done on the group in the area.

The section on marine phytoplankton (121 species) was contributed by Gunnar Seidenfaden of Copenhagen, and that on fresh-water diatoms (192 species) by Robert Ross of the British Museum (Natural History). Of the 79 species of fungi carefully and critically studied by the late David H. Linder, six are new species. The section on lichens was prepared by the late Bernt Lynge of Oslo, and includes citations of 275 species. The mosses, second to the algae in number of species (304), were treated by W. C. Steere, and the Hepaticae (78 species) was done by N. Polunin himself. Without question, this volume will be of immense value to those working in the area and its publication, although delayed nearly ten years by the war, should stimulate research of a similar nature in the Arctic.

One cannot fail to be impressed by the numerous footnotes added chiefly by Polunin for all the groups treated. While in some instances these were necessitated by developments which occurred in the prolonged period between the time the manuscripts were received and the time of publication, in other cases they seem to be unwarranted intrusions by the General Editor on the conclusions and opinions of his collaborators. The end result is an aura of editorial meddling which detracts from the authoritative air such a volume should possess.

F. K. SPARROW

DIE PILZE. *Grundzüge Ihrer Entwicklungsgeschichte und Morphologie. Lehrbücher und Monographien aus dem Gebiete der Exakten Wissenschaften 19. Reihe der Experimentellen Biologie. Band IV.*

By Ernst Gäumann. Verlag Birkhäuser, Basel. Sw. fr. 38.00 (cloth); Sw. fr. 34.00 (paper). 382 pp.; ill. 1949.

This excellent volume follows in the main the outline of the author's earlier and more extensive book, *Vergleichende Morphologie der Pilze.*

After a brief preface, which includes a schematic diagram of Gäumann's ideas on the phylogeny of the fungi, the first of the four classes (Archimycetes, Phycomycetes, Ascomycetes, Basidiomycetes) into which the fungi are grouped is discussed. All classes but this first one, the Archimycetes, follow the traditional interpretation of the main fungus classes.

In the Archimycetes we see once more, as in the previous treatise, organisms grouped together which possess, in contrast to "true fungi," a naked vegetative

phase that is converted as a whole into a reproductive structure. The resulting aggregation contains fungi with posteriorly uniflagellate zoospores (the Olpidiaceae and Synchytriaceae), together with those with heterokont (the Plasmodiophorales) or with isokont zoospores (the Olpidiopsidaceae).

Each family is briefly characterized, and its asexual and sexual cycle described. Although certain pertinent biological features, such as parasitism, etc., are sometimes included, the strict limitation of the book to morphology has necessitated the omission of many interesting aspects of the fungi under discussion. Important genera are discussed, but no detailed taxonomic account beyond the level of the family has been attempted. Following the Basidiomycetes comes a very brief summary of the Fungi Imperfecti. The volume terminates with an alphabetical list, by authors, of the literature cited, and an index.

There are many outstanding features in Gäumann's book. It is first of all a thoroughly up to date, concise, treatise on the morphology of the fungi, done in clear, readable German. The newer literature has been carefully surveyed and appropriately utilized in connection with what has gone before. Missing are many of the outworn, well-nigh classic figures of 19th century mycology. These have been replaced by illustrations from more recent papers. The figures themselves are uniformly accurate, excellently executed, and pertinent. It is to be hoped that an accurate translation into English will not ere long be forthcoming.

F. K. SPARROW

MOSSES OF GUATEMALA. *Fieldiana: Botany, Volume 25.*

By Edwin B. Bartram. Chicago Natural History Museum, Chicago. $4.00. vi + 442 pp.; ill. 1949.

Based largely on material collected on several expeditions made to Guatemala by staff members of the Chicago Natural History Museum (formerly the Field Museum), this book is essentially a manual for the identification of the moss flora so far known from that republic. The author, who has already published similar treatments of the mosses of the Hawaiian Islands and of the Philippine Islands, has provided descriptions and original illustrations of 519 species in 205 genera. Bryologists will find interest in such details as the full bibliographical citations, the reasonably full listing of synonymy, and the citation of Guatemalan specimens seen. The non-specialist will also be grateful for the keys to the genera of each family that has more than one genus, and for the keys to the species of each genus. The richness of the Guatemalan moss flora, with its 519 species, is most easily understood upon comparison with that of any of the United States, since no state, even the best known, has more than 400 species, and very few have as many as 300. Nevertheless, the author intimates that another 100 species of mosses still remain to be discovered in Guatemala. This surprising wealth of mosses in a republic no larger than Tennessee or Virginia is ascribed to the great range of altitudes from sea level to permanent snow, the enormous variation in climate, rainfall, and vegetation, and the availability of rich floras on both the north and the south.

The general biogeographer interested in the distribution of tropical plants will find data of basic phytogeographical significance in the introduction to this book and in the statements of the general geographic range of each species. The author recognizes three general groups of mosses, the lowland species of circum-Caribbean distribution, those species characteristic of the interior highlands, and the alpine species of the higher mountain summits, each group represented by its own special families. He then identifies several floristic elements and lists 26 species of a distinctly north temperate affinity, typical of the northern United States and Canada; 14 typical Andean species; 3 tropical Brazilian mosses representing 3 genera new to North America; 23 well-known Caribbean species, found principally in the eastern lowlands; 18 species of local mosses which extend north through Mexico to Arizona and New Mexico; and a smaller group of 6 species that extends into California. The author has anticipated some criticism that the moss flora of Guatemala is too little known to justify the preparation of a manual in this form, and explains that his work is explorative. In spite of the faults of any pioneer study of a new area, cheerfully acknowledged here by the author, this book provides the first useful approach to the moss flora of any restricted tropical American area.

WILLIAM C. STEERE

THE NATIVE TREES OF FLORIDA.

By Erdman West and Lillian E. Arnold. University of Florida Press, Gainesville. $3.75 (cloth); $3.00 (paper). xx + 212 pp.; ill. 1948.

The native plants of Florida have long been of particular interest to American botanists. Perhaps the principal reason is the large number of species of tropical distribution which are confined in this country to the Florida Peninsula. Among these the arborescent species form a conspicuous element. The present work, by two botanists of the Florida Agricultural Experiment Station, is concerned with such species, but also covers all native trees, including those whose natural distribution embraces areas to the north of the state.

Following a short introduction which includes a useful county map of Florida showing distributional

areas, there is an artificial key leading to generic or family groups. No key to species is included, but this will probably lead to few difficulties in identification because of the relatively small number of species in each keyed category. Each species is presented on a single page, which includes a line drawing of foliage and floral structures, in addition to paragraphs giving a description, distinguishing characters, and general comment—the latter consisting of a few concise remarks on the geographical and ecological range of the species in Florida, its uses, and other pertinent information. A list of references, a brief glossary, and an index complete the book. The volume is attractively bound and well printed. It should prove most useful to an increasing number of students of Florida plants—both amateur and professional.

NORMAN H. GILES, JR.

THE VALLEY OF FLOWERS.

By Frank S. Smythe. W. W. Norton & Company, New York. $5.00. 325 pp. + 16 plates; text ill. 1949.

The vastness and inaccessibility of the Himalayan mountains are enough to make any travelogue about them worth investigation. When spiced with botanical observations, as this book is, its value to the botanist and gardener is heightened by the fact that the Himalayas are as rich in floral species as any section of the globe. A goodly proportion of our well-known garden species are native there, even though but a small segment of the region has been adequately explored by plant collectors. A comparison of genera will also reveal the floral relationships of these mountains to those of the southeastern United States. These facts, however, are to be derived only incidentally from the chapters, for Smythe writes from the point of view of an amateur botanist, struck by the floral panorama as it shifts with altitude and with the seasons. Other than listing the species encountered, the scientific value of the book is slight. It will provide, however, an interesting evening's reading.

C. P. SWANSON

ECONOMIC BOTANY

HUMUS AND THE FARMER.

By Friend Sykes. Rodale Press, Emmaus, Pennsylvania. $4.50. xxii + 392 pp.; ill. 1949.

The author is a successful English farmer who describes in considerable detail his farming practices on the Salisbury plain, Wiltshire, and his reasons for performing them. His delightfully naive style has not been spoiled by a ghost writer. On the other hand the book contains considerable correspondence, lecture comments, quotations, and other material which might well have been condensed. As the title would suggest, the author has devoted considerable space to discussing the making of composts and the importance of organic matter. He admits that with hand labor compost-making is prohibitively expensive on most, if not all, farms. He describes the mechanical contrivances which he has developed to reduce the amount of manual labor needed and so to make compost-making practicable on English farms. Being a devotee of the organic school, the author vents some very strong and at times unreasonable opinions against the use of commercial fertilizers. Furthermore, his lack of scientific training leads him to be hyper-critical of the fertilizer trade and its standards of doing business. This book is interesting in that it shows how a resourceful and courageous farmer can adapt his farming practices to local needs and conditions, with great benefit to himself; and this, rather than any scientific or technical suggestions that might be directly useful to Americans, is the principal value of the book to us. Because Sykes travelled in the United States during the height of the depression, his comparisons between British and American farming are hardly fair; yet he seems to be under the impression that such conditions as he saw still prevail in this country. Indeed, the book was actually written toward the end of the war, when British farming conditions and controls, and their results, were very different from those prevalent in the United States during the depression. Though the halftone illustrations are disappointing, the book is nicely printed. The Rodale Press deserves credit for making available to American readers such unusual books as this. The glossary of peculiarly English farming terms, foreign to the United States or with different meanings here, is inadequate for the American reader.

ROBERT L. PENDLETON

MAKE FRIENDS WITH YOUR LAND. *A Chemist Looks at Organiculture.*

By Leonard Wickenden; foreword by Joseph W. Frazer; illustrated by E. W. Bartlett. The Devin-Adair Company, New York. $2.50. x + 132 pp.; ill. 1949.

This small book presents the opinions and experiences of an amateur gardener and devotee of the cult of organiculture. The author claims that his main purpose is to demonstrate that organiculture is not based on black magic. At least he makes out a good case for the conservation of organic matter and its use in composts. In this he is undoubtedly justified, for there is no question but that as great a use of organic matter in all forms of gardening and agriculture as can be afforded is to be highly commended and encouraged. On the other hand, perhaps because the author is a

chemist, his objections to the use of chemical fertilizers are weak. Yet more strangely, he does not seem to take very seriously the importance of minor elements in many soils and the necessity for applying them. While it is undoubtedly true that the use of metallic poisons against insect pests and for the control of plant diseases has led to the accumulation of serious quantities of poisonous substances in the soil, it is difficult to believe with the author that the generous application of organic matter instead of chemical fertilizers to the soil will so completely eliminate insect pests and diseases that spraying will no longer be needed. The attractive printing and binding of this small book is enhanced by its woodcuts and end-papers. But how much better it would have been if the author could have presented some halftones to illustrate some of the conditions he has described and discussed.

ROBERT L. PENDLETON

FARM SOILS. *Their Management and Fertilization. Fourth Edition.*

By Edmund L. Worthen. John Wiley & Sons, New York; Chapman & Hall, London. $3.80. xiv + 510 pp.; ill. 1948.

Although this edition maintains the textbook style of the third, considerable new material has been added. A careful comparison with the third edition, page by page, shows at least slight revision on more than half the pages. References to experiment station publications have been omitted. The treatment of soil erosion has been greatly expanded. Two new sections have been introduced, namely, on utilizing temporary pastures and on establishing poultry pastures. By implication, this book attempts to cover the soils of the entire United States. Actually, however, it is applicable mainly to the northeastern quarter of this country.

ROBERT L. PENDLETON

SOIL FERTILITY. *English Version of the Revised Sixth Afrikaans Edition.*

By I. de V. Malherbe. Geoffrey Cumberlege, Oxford University Press, London, New York, and Cape Town. $6.50. xii + 296 pp. + plates; text ill. 1948.

This is an extremely interesting book, written in South Africa for use there. It has been written (a) for high school pupils who have chosen agricultural science as one of their subjects for the matriculation or senior certificate examination; (b) for prospective young farmers and soil-conservation officers who are attending the two-years' diploma and other courses at the Colleges of Agriculture; (c) as an introductory reader for university students who follow degree courses in Agriculture, Forestry, or Soil Conservation; and (d) for South African farmers of all ages who desire to increase their knowledge of the medium on which their prosperity depends. As the author says, these are the people who have 'to deliver the goods,' and they must accomplish this without leaving to posterity an impoverished soil. Again and again one notes statements that phosphorus is usually seriously deficient in South African soils—evidently this deficiency is widespread and serious.

This book is a refreshing change from the usual run of textbooks published on this same general subject in the United States. The translation into English has been done very well. If the price were not so high, it could be heartily recommended.

ROBERT L. PENDLETON

A HANDBOOK OF TROPICAL AGRICULTURE.

By G. B. Masefield. Oxford University Press and Geoffrey Cumberlege, London. $4.00. viii + 196 pp. 1949.

Because of its comprehensive title this is a disappointing book. Moreover, the price seems exorbitant. After reading it, the reviewer, who has had a quarter century of agricultural experience in tropical Asia wrote to the author concerning the inadequacies and shortcomings of the book. The author replied that his book was partly intended to serve as a textbook for colonial service students who are taking short courses at universities in England and who, while not agriculturalists, have in a very short period to learn a little about tropical agriculture, with a strongly practical bias. He went on to say that his main job at the School of Agriculture of Oxford University is to teach such people. He also hoped that his book might be used in higher schools and colleges in Africa and other colonies. He added that students in England are nowadays very poor and in African colonies even more so. Hence the book had to be as cheap as possible, a factor which involved great condensation and such other restrictions as the absence of a bibliography. This also led him to draw his examples largely from the British colonies in Africa in greater proportion than from other areas. It is evident that even though this book may suffice for the purposes for which it was written, it cannot be recommended for North American readers nor for use in southeastern Asia.

ROBERT L. PENDLETON

MINERAL DEFICIENCY IN PLANTS ON THE SOILS OF THE NINETY-MILE PLAIN IN SOUTH AUSTRALIA. *2. Effect of Zinc, Copper, and Phosphate on Subterranean Clover and*

Lucerne Grown on Laffer Sand, near Keith. Council for Scientific and Industrial Research, Bulletin Number 234.

By D. S. Riceman. Council for Scientific and Industrial Research, Melbourne. Free upon request (paper). 45 pp. + 16 plates. 1948.

This publication shows the extreme complexity of the problem of supplying the widely differing needs of different species of pasture plants growing together in the relatively very infertile Laffer sand. The beneficial effects of certain elements were not obtained without adding certain amounts of some other element or elements. But the interrelationships and amounts were found to differ for each of the important components of the pasture soil. Sixteen halftone plates help one to understand the magnitude of the effects found. The overseas reader will feel the lack both of an appropriate map of the region in relation to Australia as a whole, and of the botanical names of the several plants.

ROBERT L. PENDLETON

FLOWERS IN WINTER.

By Patrick M. Synge. Lindsay Drummond, London. 15s. 122 pp. + 44 plates. 1948.

Written by an Englishman for English gardeners, this book can be read with pleasure and profit by gardeners anywhere. It concerns itself with the perennials, bulbs, tubers, and shrubs which, when judiciously used, can extend the flowering season into the winter months. To the American gardener, however, the title will be somewhat misleading, for many of the species discussed would be classified among our early spring rather than late winter flowers. Many, too, will not be hardy in our more northern states. The informed gardener will, however, recognize these discrepancies as due to the mildness of English winters while at the same time he will enjoy Synge's light, but discriminating, style and his excellent photographs. The colored plates are not on a par with the monochromes.

C. P. SWANSON

THE GARDENER'S TRAVEL BOOK. *The Massachusetts Horticultural Society.*

By Edward I. Farrington. Oxford University Press, New York. $4.00. x + 278 pp. + 32 plates. 1949.

To the gardener who combines a love for travel with a love for gardening, this is a unique and invaluable volume. It is an index of the gardens of the United States, Canada, and Mexico, arranged alphabetically as to states and locations within states. But it is also much more than an index. In his descriptions of gardens, public and private, as well as commercial, Farrington has included a wealth of information on specialty plantings, availability to visitors, height of blooming season, etc., information which will permit the motoring gardener to plan an itinerary peculiarly suited to his desires with the least inconvenience in distance and time. Included are some sixty black-and-white photographs of excellent quality, depicting some of our most outstanding garden spots.

C. P. SWANSON

GENERAL AND SYSTEMATIC ZOOLOGY

PRÉCIS DE BIOLOGIE ANIMALE. *Third Edition, Revised and Corrected.*

By M. Aron and P. Grassé. Masson et Cie., Paris. 1100 fr. viii + 1235 pp.; ill. 1947.

The preface to this third edition states that because of the recent war, access by the authors to foreign publications in biology was difficult and at times impossible. Therefore this edition has not undergone any profound alterations, although certain paragraphs and even some chapters have been revised. The contents are divided into five parts: a) the cell and general phenomena of reproduction; b) cellular physiology; c) the life of organisms in a state of equilibrium; d) the animal groups; e) the evolution of organisms. Each of these is further subdivided into chapters. The coverage is broad, and the reviewer admits quickly and frankly that he hasn't read all the 1235 pages of the text. Examination of a chapter here and there has failed to reveal any major deficiencies that would have resulted from the writers' overlooking any of the more recent discoveries. Rather, the treatment is most up to date (e.g., *Australopithecus, Meganthropus,* and *Gigantopithecus* are included in the evolution of the Primates), especially when compared to many American text books. Indeed, it proves difficult to find a basis for comparing the present volume with certain standard American zoology text books. The amount of material included by Aron and Grassé is too great for any one year's work. It is more of a compendium of a full four years' major in zoology in this country (plus some graduate level work). Consequently it combines what we can find only in several textbooks for different courses, a sort of expanded combination of a "Plunkett" and a "Hegner." One wonders where such a book would fit into our zoological training system. There is no doubt that a candidate for an advanced degree, were he to read this one volume, would be prepared for any sort of examination. Naturally, each major topic fails in completeness of detail; and some fields, like ecology, are not even mentioned. On the other hand, it is convenient to have so much information all in one place, including, in spite of the broad field to be covered, bits of information not common in textbooks. There are 719 figures, most of which have been drawn from

European sources and for that reason are of additional value to American biologists. There is an index, but only a pretence of a bibliography.

HENRI C. SEIBERT

TRAITÉ DE ZOOLOGIE: *Anatomie, Systématique, Biologie. Tome VI. Onychophores, Tardigrades, Arthropodes, Trilobitomorphes, Chélicérates.*

By M. André, L. Berland, L. Cuénot, C. Dawydoff, L. Fage, J. Millot, L. Störmer, M. Vachon, A. Vandel, and G. Waterlot. Masson et Cie., Paris. 5000 fr. viii + 979 pp. + 5 plates; text ill. 1949.

TRAITÉ DE ZOOLOGIE: *Anatomie, Systématique, Biologie. Tome IX. Insectes: Paléontologie, Géonémie, Aptérygotes, Ephéméroptères, Odonatoptères, Blattoptéroïdes, Orthoptéroïdes, Dermaptéroïdes, Coléoptères.*

By L. Chopard, R. Denis, R. Despax, P.-P. Grassé, R. Jeannel, and R. Paulian. Masson et Cie, Paris. 4500 fr. viii + 1117 pp. + 3 plates; ill. 1949.

TRAITÉ DE ZOOLOGIE: *Anatomie, Systématique, Biologie. Tome XI. Échinodermes, Stomocordés, Procordés.*

By P. Brien, M. Caullery, L. Cuénot, A. Dalcq, C. Dawydoff, P. Drach, H. Harant, and G. Waterlot. Masson et Cie., Paris. 3800 fr. viii + 1077 pp.; ill. 1948.

The appearance of a new treatise on zoology will be welcomed by zoologists the world over. The existing treatises are either so old as to retain very little value or else they remain, like the great German treatises, in a perpetually incomplete state, very exasperating to the user. The energy and speed with which the volumes of the French treatise are appearing—three in rapid succession in 1949 and others promised within a year or two—augurs well for the eventual completion of the set within a reasonable time, well before the first volumes have become outmoded.

In these volumes the emphasis is placed on anatomy and its handmaiden, embryology. Most of the space allotted to each group is given over to an account of the anatomy. This account is reasonably full and adequate, proceeding system by system, and well illustrated by large, clear, and neat figures, in many of which color has been employed to emphasize certain systems. This is followed by an account of the embryology, then by a brief section on systematics, which wisely makes no attempt to go beyond genera, and by a closing discussion of phylogenetic questions. The outstanding defect of these excellent volumes is the almost complete lack of any discussion of ecological and physiological topics. This appears to the reviewer a most unfortunate omission that lends an impression of old-fashionedness to what is otherwise a highly satisfactory performance. The bibliographies at the end of each group are limited to the larger works, and there is little documentation in the text.

The treatise is announced to consist of 17 volumes, of which there have appeared in 1949 volumes XI, VI, and IX, dealing with invertebrates and prochordates.

Volume XI. Échinodermes, Stomocordés, Procordés.

The account of the echinoderms, by L. Cuénot, is happily given over mainly to the living groups, classified into the usual five classes, and thus avoids that undue emphasis on fossil echinoderms that was the glaring defect of the echinoderm volume in Lankester's *Treatise on Zoology*. The fossil echinoderms are briefly treated as classes Machaeridia, Heterostelea, Cystidea, Blastoidea, and Edrioasteridea. The last is considered phylogenetically important for the origin of the living groups. A generous section on echinoderm embryology and metamorphosis, by C. Dawydoff, suffers from the habitual tendency of this author to produce his own or at least unfamiliar names for many embryonic features. The dipleurula larva is accepted as the point of departure for discussions of phylogenetic questions regarding echinoderms. It is considered to indicate an original bilaterality that was altered by the assumption of a fixed mode of life. The dipleurula larva is presumed to have attached by its preoral lobe, and possibly an asymmetrical mode of attachment may account for the suppression of the right side in favor of the left so characteristic of echinoderms. It is accepted that all free-moving groups of present echinoderms descended from fixed ancestors.

The Hemichordata, also by Dawydoff, are treated under the name Stomochorda, to avoid implications of the former name. There is an excellent account of the group, divided into the usual two classes, Enteropneusta and Pterobranchiata. The two peculiar organisms *Planctosphaera*, found in 1910 by the Michael Sars Expedition and later also elsewhere, and Siboglinum, collected in the Malay Archipelago by the Siboga, are presented as undoubtedly of hemichordate affinities. There is also included in the phylum the fossil group of graptolites, as a class Graptolitoidea. The graptolites were formerly thought to be coelenterates but researches of recent years leave little doubt of their affinity with the Pterobranchiata. The notion of the notochord affinity of the anterior diverticulum of the typical hemichordates is altogether rejected, and the structure, termed "stomochord," is considered to represent an anterior part of the pharynx that once opened by a mouth anterior to the present mouth. Chordate affinity of the hemichordates is, however, accepted, mainly on the ground of the presence of gill slits (pharyngotremy) which are presumed to have originally extended the length of the digestive tract. Echinoderm affinity is also affirmed on the basis of larval similarity.

The tunicates are given an extensive treatment by P. Brien, aided by A. Dalcq and P. Drach in some general introductory remarks. The last author rightly rejects the conception of a group Prochordata to embrace tunicates and cephalochordates and retains these as

separate subphyla of the Chordata. The volume closes with an account of the Cephalochordata by P. Drach, who considers this group to represent a small side branch of the chordate stem, without direct ancestral relationship to the vertebrates.

Volume VI. Onychophores, Tardigrades, Arthropodes, Trilobitomorphes, Chélicérates.

The onychophores, tardigrades, and pentastomids, handled by L. Cuénot, are excluded from the phylum Arthropoda although regarded as closely allied to it. The Arthropoda are divided into the subphyla Trilobitomorpha, Chelicerata, and Mandibulata or Antennata. An interesting introductory chapter to the Arthropoda, by A. Vandel, precedes the more specific accounts. Vandel concludes that it is impossible to homologize the different body regions and segments of groups of arthropods and that the conception of a primitive arthropod body of 21 segments is unacceptable and false. An annelid affinity of arthropods is accepted.

The Trilobitomorpha, divided into the classes Trilobita, Merostomoidea, Marellomorpha, and Pseudocrustacea, are discussed by L. Störmer, who submits that these somewhat diverse groups are united by their common possession of a trilobite type of appendage. They are probably related to the Chelicerata.

The remainder of the volume is devoted to the Chelicerata, divided into the classes Merostomata, treated by L. Fage; Arachnida, handled by L. Fage, J. Millot, C. Dawydoff, M. Vachon, L. Berland, M. André, and G. Waterlot; and Pycnogonida, by L. Fage.

Volume IX. Insectes. Paléontologie, Géonémie, Aptérygotes, Ephéméroptères, Odonatoptères, Blattoptéroides, Orthoptéroides, Dermaptéroides, Coléoptères.

This volume begins with some general chapters on insects, including fossil insects, by R. Jeannel. This author accepts the classification of Martinov, who has divided the insects into the subclass Apterygota, with four orders, and the Pterygota, with 33 orders. Distinction is also made between the Paleoptera, with seven orders, in which the wings cannot be folded, and the Polyneoptera, with 26 orders, in which the wings are folded together in repose. The section on fossil insects attempts to correlate the evolution of insects with successive topographies of the various geologic ages.

The remainder of the volume deals with the lower orders of insects and is written by a number of authors (L. Chopard, R. Jeannel, R. Denis, P. Grassé, R. Despax, and R. Paulian). Like the rest of the treatise, these articles are mainly anatomical, with only brief considerations of habitat relations and geographical distribution. Exception may be made of the chapter on termites, by P. Grassé, in which there is a considerable discussion of the determination of castes, the social life of termites, the morphological and ecological peculiarities of the various castes, the symbiotic relationship with flagellates, and the various types of nests and mounds.

L. H. HYMAN

A MONOGRAPH OF THE ECHINOIDEA. *IV.1. Holectypoida, Cassiduloida. IV.2. Text and Atlas. Clypeastroida: Clypeastridae, Arachnoididae, Fibulariidae, Laganidae and Scutellidae.* (*2 Vols.*)

By Th. Mortensen. C. A. Reitzel, Copenhagen. (IV.1) D. Kr. 62.00; (IV.2) D. Kr. 100.00 (paper). (IV.1) viii + 372 pp. + 14 plates; text ill. (IV.2, Text) viii + 471 pp.; ill. (IV.2, Atlas) viii + 20 pp. + 72 plates. 1948.

These three paper-covered volumes represent the fourth part of Mortensen's well-known monograph on the Echinoidea and, like the preceding parts, will prove indispensable to all students of this group.

A GENERAL TEXTBOOK OF ENTOMOLOGY *Including the Anatomy, Physiology, Development and Classification of Insects. Seventh Edition.*

By A. D. Imms. E. P. Dutton & Co., New York. $12.50. xii + 727 pp.; ill. 1948.

The changes by which this edition differs from earlier ones are of minor significance. The most up to date of the supplementary references is that to Comstock's general textbook, 1940. This new edition is thus at least ten years old. Not least of the dangers inherent in the manifest reedition of old, tried-and-true textbooks lies in the fact that erroneous information is perpetuated. Witness, for example, the discussion of campaniform sense organs (p. 96). This concludes with the statement that "... their true sensory function remains problematical." Yet more than ten years ago Pringle, in England, demonstrated conclusively that campaniform sensilla are proprioceptors (*J. exp. Biol.*, 15: 114–131. 1938).

The excellence of Imms' great work has not diminished through the years, but anyone who already possesses an earlier edition will have little to gain by acquiring the seventh.

V. G. DETHIER

HOW TO KNOW THE IMMATURE INSECTS. *An Illustrated Key for Identifying the Orders and Families of Many of the Immature Insects With Suggestions for Collecting, Rearing and Studying Them.*

By H. F. Chu. Wm. C. Brown Company, Dubuque. $3.00 (cloth); $2.00 (spiral). vi + 234 pp.; ill. 1949.

This interesting volume is one of The Pictured-key Nature Series edited by H. E. Jaques. The subtitle clearly describes its contents. Almost the entire volume consists of keys, with the illustrations so arranged as to explain the characters used. It is not possible for a reviewer to do more than call attention to the well arranged order of the work, its clear illustrations, and its brevity. Anyone using the keys will find many difficulties and errors that will try his patience; yet the attempt to do the almost impossible in devising satisfactory keys to the immature stages of the various orders and numerous families of insects is to be highly commended. The author gives the beginner a brief but interesting account of the early stages of insects and how they may be collected, reared, and preserved. There is an adequate index and a pictured glossary arranged in a single unit. The bibliography is not very complete.

ROBERT MATHESON

LES COCHENILLES DE FRANCE, D'EUROPE, DU NORD DE L'AFRIQUE ET DU BASSIN MÉDITERRANÉEN. *Monographie des Coccoïdea Classification—Diaspidinae (Première partie). Actualités Scientifiques et Industrielles, 1054; Entomologie Appliquée, IV.*

By A. Balachowksy; illustrations by Gérard Langlois. Herman & Cie., Paris. 600 fr. (paper). 154 pp. [Pp. 241–394 of set]; ill. 1948.

Of the six volumes planned for the *beginning* of this ambitious work on palearctic coccids, Balachowksy has now published the first four, the present volume having been long delayed by the war. Volumes I and II appeared in 1937, and III in 1939. The first three volumes complete a general study of the scale insects, especially of their morphology, while this fourth volume considers the major taxonomic groupings inclusive of the subfamilies, and embarks on the revision of the first group (Diaspidinae: Aspidiotini: Aspidiotina), of which 32 species in 9 genera are considered in detail.

The present volume is printed on heavy pulp, is uncut, and has a paper cover, but the reproduction of the 32 full-page line cuts is adequate. The manuscript could have been edited more closely, for there are a few inconsistencies in format and errors in pagination and spelling of proper names that should have been corrected. But one's general impression is very favorable, with the reservation that the value of the work will depend greatly on the publication of the rest of it. The key to genera, as well as the full bibliography, are due at the end of each group revised, so that one must wait for volume VI in order to find those for the tribe Aspidiotini.

The author divides the Homoptera into superfamilies, with the Coccoïdea for the scale insects. The Cicadoïdea (inclusive of the Cicadidae, Cercopidae, Membracidae, etc.) Amphidoidea, Aleyrodoidea, and Psylloidea represent the other divisions. Under the Coccoïdea he recognizes three families with 14 subfamilies (in contrast to 1 family, 17 subfamilies by MacGillivray, 1921; and 11 families by Ferris, 1937). One can well object to the author's spelling of the family names (Margaroïdae, Lecanoïdae, and Diaspidoïdae) as unorthodox and confusing, but since the significant categories, namely, the subfamilies, are in standard form, it matters little. Full keys from superfamilies to subfamilies are given, with further keys to the tribes of the Diaspidinae and the subtribes of the Aspidiotini to cover the present volume and the succeeding two volumes.

The bulk of volume IV is a monograph of the genera and species of the subtribe Aspidiotina, of which one genus is new (*Abgrallaspis*, proposed for 6 species of palearctic *Hemiberlesia*, genotype *H. cyanophylli* Signoret). Each genus is fully characterized, with the genotype given (but status of designation not clear for most) for all but *Chortinaspis* Ferris, which is an unexplained omission. The treatment of each species is rather complete, with a conventional split figure (full page line-cut) for the pygidium, with border detail as an enlargement. The author considers for each species its synonymy, reference to principal descriptions and to biological observations, diagnostic characters both macroscopic and microscopic, biology and habitat, distribution, natural enemies, and relations to other species.

An interesting problem of format is posed by the use of double pagination in these volumes, i.e., pagination for the *set* as well as for the volume. Generally speaking, such a system is hard for the author and reader to keep in order, as evidenced by the text citations, which are in pagination for the set, while the volume index is in pagination for the volume. Occasional confusion by the author himself (in the key to *Chortinaspis*, IV-143, and the text references, IV-66) illustrates the point.

ROBERT MATHESON

ATLAS DES LÉPIDOPTÈRES DE FRANCE. *Belgique, Suisse. III. Hétérocères (fin).*

By Claude Herbulot; illustrations by R. Prêchac. Éditions N. Boubée et Cie., Paris. 480 fr. (paper). 146 pp. + 12 plates; text ill. 1949.

This new volume to the series maintains the same high standards and excellent illustrations evident in the other volumes.

NEW GUINEAN REPTILES AND AMPHIBIANS IN THE MUSEUM OF COMPARATIVE ZOÖLOGY AND UNITED STATES NATIONAL MUSEUM. *Bulletin of the Museum*

of Comparative Zoölogy at Harvard College. Volume 101, Number 2.

By Arthur Loveridge. Museum of Comparative Zoölogy, Cambridge. $1.50 (paper). Pp. 303–430. 1948.

During the war many amateur and professional zoologists found themselves in what they would previously have considered to be remote corners of the earth. Many of them, due to the limiting effects of time, climate, materials, enemy action, or inclination, obtained only a handful of herpetological specimens that reached museum collections. A few were able to amass outstanding collections. Such was the material assembled by William H. Stickel, a collection which is described by Loveridge as the best he has seen from New Guinea. It is difficult to realize how important these contributions are. For example, the present paper is based upon 1809 specimens in two museums. Of these, over one-third were collected by Stickel and another third by two other interested zoologists, William H. Beck and P. J. Darlington. The remainder of the specimens were derived from an expedition, from exchanges with museums from all over the world, and from dozens of individual donations. How much more is yet to be done in New Guinea in this field of work is emphasized by Loveridge's statement that this material represents only 44 per cent of the forms known to occur there.

The New Guinean amphibian and reptilian fauna that Loveridge lists consists of 108 forms of frogs, 17 turtles, 2 crocodilians, 146 lizards, and 95 snakes. Besides listing the known herpetofauna, he has discussed the forms represented in the material studied, species by species, with a varying amount of detail per species. There are occasional keys, but no general attempt was made along those lines, inasmuch as "to compile keys on so slender a representation would inevitably lead to the perpetuation of many errors, for some of the names included in the list will certainly prove to be synonyms." Other useful features of the paper include a Gazetteer of all New Guinean localities mentioned in the text, and a list of the literature cited. Loveridge is a careful and meticulous worker with a tremendous knowledge of the herpetology of the eastern hemisphere. It is doubtful if there are many others who could have done so excellently with the same material and in the same period of time.

This appears to be an appropriate place to discuss a general problem faced by authors of faunistic studies. Suppose such an investigator wants to devote a limited, albeit substantial, amount of time to a faunal report. He finds two possible methods of using material if the time factor is to be kept within reasonable bounds. Either he can study the forms from a small geographic area but with a serious attempt to examine all the specimens in various museums collected from the area in question. Or he could study the fauna of a much larger area but with limitation to the use of the collections of a single institution. The amount of work, as measured by the number of specimens carefully studied, might be approximately the same in the two cases. In the first, however, the forms of a restricted area would be relatively well-known, whereas in the second perhaps as much biological information would be made available, but it would be spread thinner over a much larger area.

In the past, Loveridge has been in the company of a small number of curators who have rather consistently followed the second procedure. No doubt he has viewed it as his primary responsibility to describe adequately the material entrusted to his care in the Museum of Comparative Zoology. Other curators, however, view (or are permitted or encouraged to view) their responsibilities somewhat differently and normally follow the alternate procedure. In the present paper, Loveridge has made use of an additional collection besides his own, namely, that of the United States National Museum. Whether this indicates a change in policy in herpetology at the Cambridge institution or only an expedient measure because of an unusual set of circumstances, only time will tell. Loveridge hints that the latter is true and that, therefore, no persistent change is to be expected. Many, however, will hope with the reviewer that this paper indicates a real trend towards a change in procedure. If there are to be, for example, three studies on three island faunas, a literature with three such titles as "The Frogs of Islands A, B, and C in the X Museum," "The Frogs of Islands A, B, and C in the Y Museum," and "The Frogs of Islands A, B, and C, in the Z Museum" would not be as desirable as a literature with the three titles "The Frogs of Island A" by the Curator of X Museum, "The Frogs of Island B" by the Curator of Y Museum, and "The Frogs of Island C" by the Curator of Z Museum. The more intensive work on the individual islands should, in general, precede the comparative studies of the faunas of these islands. In all fairness, however, it should be pointed out that there are frequently extenuating reasons for reporting on a single collection from an area in a separate publication.

ARNOLD B. GROBMAN

REPTILES FROM THE INDIAN PENINSULA IN THE MUSEUM OF COMPARATIVE ZOÖLOGY. *Bulletin of the Museum of Comparative Zoölogy at Harvard College, Volume 103, Number 2.*

By John D. Constable. Museum of Comparative Zoölogy at Harvard College, Cambridge. $1.25 (paper). Pp. 57–152. 1949.

Several years ago I had a conversation with an informed and well-rounded biologist whose field of special interest is plant physiology. We were discussing the character-

istics of good taxonomic work. He pointed out that, were he in a position to add a new member to his staff, he would welcome a taxonomist who was concerned with the relationships among the organisms he was dealing with; he would not, however, be interested in a man who considered the pure cataloging of material to be his terminal job. It seems obvious that my physiologist friend would never offer a position to the author of this paper. For we find Constable saying on the initial page of his report:

"Taxonomy in itself may seem to be of rather little use, but it is an essential adjunct to other important areas of biology. I believe it to be, in general, a tool developed by scientists for their convenience and that therefore the rules and methods that are adopted for its development should be largely determined by their usefulness rather than by more or less abstract concepts of 'natural distinctions.' It may, for example, be true that two races of snakes can be distinguished on the basis of differences in the hemipenis, but I consider the difference to be unworthy of taxonomic recognition as long as the females are indistinguishable. Even if the hemipenis differences should be shown to have such a profound effect upon their breeding habits as to prevent crossbreeding of the two forms, I would still consider a new name inconvenient and hence, almost by definition, unnecessary."

In recent years we have been favored with many treatments about taxonomic procedure: *The New Systematics; Systematics and the Origin of Species; Evolution, the Modern Synthesis;* and *Genetics, Paleontology and Evolution*. For a serious student of taxonomy to hold to a pre-Darwinian and pre-Mandelian concept about systematic procedure in the face of such literature is, indeed, a most amazing anachronism. Such a performance lends support to the thesis that there are two kinds of persons studying the classification of animals: taxonomists and systematists.

There are two steps in good systematic work. So far I have decried the lack of the author's appreciation for the second step. The first step is the association of animal characters with animal names. This seems to have been done carefully and well in the present study. Constable found 775 Indian specimens in the Museum of Comparative Zoology representing two forms of crocodilians, 13 turtles, 93 lizards, and 112 snakes. Two new species are described, one a gecko and the other a small burrowing blind snake of the genus *Typhlops*. Under each species there is given the original citation, the type locality when definable, and the catalogue numbers of the specimens in the M. C. Z. There are also given locality data and taxonomic characters for the specimens at hand. The latter are quite extensive in some cases and, in a few instances, keys have been prepared to distinguish closely allied forms.

The paper closes with a list of the literature cited which is erroneously headed: "Bibliography." The review copy was incomplete in that the last signature was missing.

ARNOLD B. GROBMAN

SNAKES.

By Herbert S. Zim; illustrated by James Gordon Irving. William Morrow & Company, New York. $2.00. 66 pp.; ill. 1949.

The young naturalist should be fascinated by this book on snakes. Dealing with the biology of snakes in a comprehensive manner, it will do much to place the snake properly in the biological order of things, as well as to remove the fears and superstitions which surround them. The kinds of snakes, their modes of reproduction and feeding, and their care are handled in straightforward simple sentences, and balanced with a fine group of black-and-white drawings by J. G. Irving. It is recommended for the growing and inquisitive naturalist.

C. P. SWANSON

BOY'S BOOK OF SNAKES. *How to Recognize and Understand Them.*

By Percy A. Morris. The Ronald Press Company, New York. $3.00. viii + 185 pp.; ill. 1948.

Good books about snakes for the beginner are few. In fact, those designed to be read for entertainment rather than used like a manual can be counted on the fingers of one hand. The *Boy's Book of Snakes* is a highly simplified and well-written account, with emphasis on the species common in the United States (seven chapters) but including a very brief account of foreign forms (two chapters). The treatment is largely ecological and omits scientific names. However, all kinds mentioned are classified in a list that precedes the index. There is also a list of authorities cited and a brief bibliography. Some of the numerous half-tone illustrations are good, others poor.

A few errors have crept in. Stejneger's myth of the rattler 8 feet 9 inches long has been perpetuated, along with the belief that poisonous snakes usually make only two punctures when they bite. Nevertheless, I would not hesitate to recommend this little book to a boy or girl with a growing interest in reptiles.

CLIFFORD H. POPE

BIRDS. *A Guide to the Most Familiar American Birds. A Golden Nature Guide.*

By Herbert S. Zim and Ira N. Gabrielson; illustrated by James Gordon Irving. Simon and Schuster, New York. $1.00. 157 pp.; ill. 1949.

While not as comprehensive in treatment as the field guides by Peterson, this pocket volume is an excellent book for the beginner. The colored illustrations by J. G. Irving are accurate in color and proportion; and the descriptions, while brief, provide the necessary supplementary data on distribution, habitats, and habits. A table at the back of the book provides a compact summary of migration dates, egg size and number, nesting materials and location, and food habits.

C. P. SWANSON

CATALOGUE OF BIRDS OF THE AMERICAS AND THE ADJACENT ISLANDS IN FIELD MUSEUM OF NATURAL HISTORY. *Including All Species and Subspecies Known to Occur in North America, Mexico, Central America, South America, the West Indies, and Islands of the Caribbean Sea, the Galapagos Archipelago and Other Islands Which May Be Included on Account of Their Faunal Affinities. Jacanidae, Rostratulidae, Haematopodidae, Charadriidae, Scolopacidae, Recurvirostridae, Phalaropodidae, Burhinidae, Thinocoridae, Chionididae, Stercorariidae, Laridae, Rynchopidae and Alcidae. Zoological Series, Field Museum of Natural History, Volume XIII, Part I, Number 3, Publication 616.*

By Charles E. Hellmayr and Boardman Conover. Field Museum of Natural History, Chicago. $4.00 (paper). vi + 383 pp. 1948.

The present number of this extensive catalog of birds of the Americas (Western Hemisphere) lists the members of the Order Charadriiformes. This order includes the jacanas, painted snipe, oyster-catchers, plovers, sandpipers, curlews, avocets, stilts, phalaropes, thick-knees, seed-snipe, sheath-bills, skuas, jaegers, gulls, terns, skimmers, and auks, a group commonly known as the shore-birds, although it obviously contains members not limited to coast lines.

The greater part of the manuscript was written by Hellmayr, and since his death has been supervised, emended, and brought up to date by the junior author. As in previous numbers of the series, each species and subspecies of bird known to occur in the Western Hemisphere has been listed with complete synonymy and bibliographic references up to 1945. New forms that have been described and a few important papers that have appeared since that date are mentioned in footnotes. Specimens in the Field Museum and in the Conover collections are listed according to locality. The range of each form is delimited. For anyone interested in avian taxonomy, this publication, like its predecessors, is a necessary and invaluable reference. For others, the extensive references will provide a good start for anyone who seeks information about a particular species, especially since the important data in each reference cited have been indicated following the citation.

HENRI C. SEIBERT

ANIMAL ENCYCLOPAEDIA. *Mammals. With Latin Index.*

By Leo Wender. Oxford University Press, New York. $4.50. 266 pp.; ill. 1949.

In the Foreword it is confidently stated that "this dictionary of animals seeks to give everybody—laymen and scientists—a short and concentrated account of the most interesting facts concerning the mammals of the world." Some 1500 mammals are listed alphabetically by their "common" English names, ranging from aardvark, acouchy and addax to zeren, zorille, and zwart-wit-pens. What this work considers as "the most interesting facts" concerning these beasts is best indicated by the first sample the reviewer happened to read: "ALPINE PIPISTRELLE, a southern Pipistrelle going above the treeline in the Alps. Usually sleeps in the cow-chalets. Body 2 in., tail 1½ in. long; wing-span 9 in. *Pipistrellus savii.*" From this the lay-reader can learn little besides that the particular winged critter sleeps in a cow-chalet (a novel architectural term). The numerous, far too small, and extremely poorly reproduced illustrations are of no help in identifying the animals, which can not be recognized from the text either. Many of the technical names of species and of the arbitrarily selected subspecies are not up to date.

Appended is a list of Gestation Periods and Numbers of Young at a Birth, which irritates the expert by making claims unsupported by any references to the literature. Thus, it lists the duration of pregnancy for the marmoset as "75—150 days," which is surely liberal enough to include the correct figure; whereas for the macaque 7 months is given, although 5½ months is all that has been well substantiated so far. Another appendix contains a Classification of Mammals which is inexcusably crude. Man is not even mentioned. The "Lemuroids" form a separate order, containing the families "Lemurs, Slow Lemurs and Tarsier," although in the text the Lemuroids are defined as representing a "sub-order of the Primates" and as "the chief elements of the mammalian fauna of Madagascar."

Enough has been said to indicate that this is a pot-boiler of the worst sort, written by someone of whom it is merely stated that he "was contributing author of the *Guide to the Berlin Zoo* and has spent over ten years in the preparation of this Encyclopaedia." It is hoped that this volume will reach all cross-word-puzzle fans, but no one who is seeking reliable zoological information on matters beyond the spelling of the names of mammals.

A. H. SCHULTZ

MAMMALS OF NORTHERN COLUMBIA. *Preliminary Report Number 4: Monkeys (Primates), With Taxonomic Revisions of Some Forms. Proceedings of the United States National Museum, Volume 98, Number 3232.*

By Philip Hershkovitz. Smithsonian Institution, United States National Museum, Washington, D. C. Paper. Pp. 323–427 + 3 plates; text ill. 1949.

The author of this scholarly study has collected over 200 specimens of capuchin monkeys, spider monkeys, howler monkeys, night monkeys, and marmosets in northern Colombia. Based upon this extensive new material, as well as upon an examination of nearly all pertinent type specimens and additional material from many other collections, a much needed taxonomic revision has been made, chiefly of the genera *Cebus* and *Marikina*. All these Colombian primates are described according to geographical distribution and the corresponding detailed differences in the characters of their hair, skull, and dentition, as well as, in the genus *Alouatta*, its highly specialized hyoid apparatus. The many technical and well documented results have not been summarized in the report and cannot be briefly summarized here. It suffices to mention that this paper will be indispensable for students of the taxonomy and geographical distribution of New World monkeys.

A. H. SCHULTZ

ECONOMIC ZOOLOGY

GALL MIDGES OF ECONOMIC IMPORTANCE. VOLUME IV: GALL MIDGES OF ORNAMENTAL PLANTS AND SHRUBS. *Agricultural and Horticultural Series.*

By H. F. Barnes; with a Foreword by G. Fox Wilson. Crosby Lockwood & Son, London. 15s. 165 pp. + 10 plates; text ill. 1948.

The title clearly indicates the scope of this volume. In the beginning there is a list of all the plants (43) treated, each with its known gall midges and the part injured. These are all discussed in detail in the following pages. The arrangement is most satisfactory, for the reader can select any plant, glance down the pages and find the list of known midges with the page references where he can find detailed accounts of the various species. Furthermore, under the discussion of each gall the author has obligingly given the most important references dealing with the species that causes the gall. Could anyone ask more? The book is most delightfully written, and the reader will learn much of interest.

Under each gall discussed there is a full account of the parasites and predators. Where control measures have been devised, these are given, and the author appears to be well acquainted with much of the work done in all parts of the world, especially in America.

This book should be a welcome addition to the library of everyone interested in knowing these galls and in keeping their ornamental plants and other shrubs free from these pests. To the entomologist the illustrations will furnish a guide to many of the midges that form these galls, inasmuch as they can be identified by their work whereas identification of the midges themselves is very difficult.

Decided attractions are a bibliography of 343 titles, a list of generic, specific, and common names of all the midges described in the book. Two indexes, one for plants and one general, complete the volume.

ROBERT MATHESON

THE STOCK OF SALMON: *Its Migrations, Preservation and Improvement, being The Buckland Lectures for 1947.*

By W. J. M. Menzies. Edward Arnold & Company, London. 5s. 96 pp. + 7 maps; text ill. 1949.

"That fact that wide variations in the catch of salmon, and therefore presumably in the stock of salmon, exist from year to year is very much better known than the causes of these variations." The author finds no convincing evidence for population cycles in Atlantic salmon, and although weather conditions may sometimes influence the population over wide areas, the greatest influence on the stock seems to be in the sea. Grilse present an interesting puzzle, for although a large grilse run may indicate a large adult run the next year, the reverse is not necessarily true. The author asks how a stock might be adversely influenced in its early years without impairing its final yield. Many migration patterns from various tagging stations are presented in the figures, but here again the data are inconclusive. This concise summary (the latest of the Buckland Lectures) of our present state of ignorance of an intensively studied fish should be salutary reading for the more dogmatic fisheries biologists—we have hardly begun to learn what goes on in the sea.

J. W. HEDGPETH

FISHERY STATISTICS OF THE UNITED STATES 1945. *United States Department of the Interior, Fish and Wildlife Service. Statistical Digest 18.*

By A. W. Anderson and E. A. Power. United States Government Printing Office, Washington, D. C. $1.50 (paper). ii + 372 pp.; ill. 1949.

THE HATCHABILITY OF CHICKEN EGGS AS INFLUENCED BY ENVIRONMENT AND HEREDITY. *A Revision of Bulletins 216 and 236. Bulletin 262.*

By Walter Landauer. Storrs Agricultural Experiment Station, Storrs, Connecticut. 50 cents (paper). 231 pp.; ill. 1948.

This bulletin is a comprehensive summary of research on inherent and environmental factors which affect the probability that viable chicks will hatch from hen's eggs following incubation. Sixteen lethal genes and several

other genes that reduce embryonic viability are described. Requirements of the developing embryo with respect to temperature, humidity, gaseous environment, orientation, and turning are reviewed. The nutrition of the hen, determining the amount of the respective vitamins, except C, in the hen's egg, and research demonstrating the requirements of the developing embryo for the various vitamins are summarized. The influence of the age of eggs when incubated, the reproductive activity of the parental stock, the growth and physiology of the embryo, and the history of incubation all receive attention. Every research worker who uses chicken eggs, and every teacher of embryology should read this bulletin.

T. C. BYERLY

FERTILITY AND HATCHABILITY OF CHICKEN AND TURKEY EGGS.

Edited by Lewis W. Taylor. John Wiley & Sons, New York; Chapman & Hall, London. $5.00. xii + 423 pp.; ill. 1949.

This book is an excellent summary of research on reproduction in chickens and turkeys. It should become a standard reference for every laboratory using eggs, embryos, chicks, or poults. Thoughtful poultry breeders, hatcherymen, and service and technical personnel in the feed, biological, and equipment industries will find it constantly useful. The book lacks a section on the normal morphological development of the embryo. Treatment of research on the growth of the embryo is inadequate. The chapter on Physical Conditions in Incubation, by Insko, is of outstanding value.

T. C. BYERLY

PARASITOLOGY

LE PARASITISME. *"Que Sais-Je?" Le Point des Connaissances Actuelles.*

By Louis Gallien. Presses Universitaires de France, Paris. 45 fr. (paper). 128 pp.; ill. 1943.

This volume is number 117 of a proposed 160 titles in a series known collectively as "Que sais-je?" The topics run a gamut from a history of the theater, French diplomacy, the life of the blind, to scientific titles dealing with television, the nervous system, the migration of animals, or the present one on parasitism. They are, of course, intended for popular consumption. The story of parasites is interestingly recounted and made sufficiently lucid for the educated layman, but is not pitched at such a low level that essential details are glossed over. There are eight chapters, the first of which defines the subject by illustrating the various degrees of associations that may exist between two forms of animals, from commensalism to parasitism. This point is well brought out by using as an illustration the relations of closely related species of paguran crabs with their respective commensals, symbionts, and parasites. Chapter II points out the wide distribution of parasites within the animal kingdom (plant parasites are not considered). The next two chapters are concerned with certain parasitic adaptations; their regressive development with respect to related free-living forms, and specializations in holdfast structures. Chapters V and VI discuss reproduction, the cycles, hosts, fecundity, and associated phenomena. Number VII describes the effects of parasite on host; and the final chapter is a discourse on evolution, wherein it is pointed out that parasites at once provide evidence for the evolutionary doctrine and at the same time pose problems on the origin of adaptive features. Although brief and at times fragmentary, the book still provides enlightening information to anyone who has an hour or so on his hands and who is willing to spend it by reading in order to increase his "Je sais que."

HENRI C. SEIBERT

VETERINARY CLINICAL PARASITOLOGY.

By Edward A. Benbrook and Margaret W. Sloss. The Iowa State College Press, Ames, Iowa. $4.50. viii + 187 pp.; text ill. 1948.

The most valuable feature of this book is the collection of many good photomicrographs of parasites of veterinary importance. Since the book is strictly limited to the clinical aspects of the subject, only the diagnostic stages of the parasites are illustrated. Usually each intestinal organism is presented in photographs taken at two magnifications, 100x and 410x. This makes it possible to compare the relative sizes of the organisms under the low power and high dry objectives of the compound microscope. The photographs of the ectoparasites were taken at lower magnifications. In all, there are approximately 240 photographs each of which occupies one half of a page. Twenty-three of the photographs illustrate techniques; 18, lice; 44, mites; 18, pseudoparasites; and the remainder, various intestinal parasites. Most of the photographs are very clear and have reproduced well.

Except for describing techniques, there is very little text in the first half of the book, which deals with intestinal parasites. For this reason, it would appear that the title is too broad for the material presented. The term "atlas" or "illustrated guide" would have been appropriate to qualify the title. Even as a guide, it would have been more complete and useful had the authors included descriptions of the diagnostic stages, host parasite lists, and perhaps notes on pathogenicity.

The text on the ectoparasites is more complete. In most instances, there is a general description of each genus, including its morphological characteristics and the effect of the parasite upon the host. The descrip-

tion of the genus is followed by a list of species with the names of the host that they parasitize. There is also a table to the characteristics of the mange and scab mites, accompanied by ten clear outline drawings to illustrate the male and female characters described.

The book has been planned so that other chapters can be added as needed and as the illustrative material becomes available. It now deals with only three groups: the intestinal parasites, the lice, and the mites. At the end of the book there are reference lists to each chapter and a detailed index.

M. M. BROOKE

VETERINARY HELMINTHOLOGY.

By Banner Bill Morgan and Philip A. Hawkins; illustrated by Everett L. Schiller. Burgess Publishing Company, Minneapolis. $7.00. xiv + 400 pp.; ill. 1949.

This is a very practical book that should prove to be a valuable possession to veterinarians and others interested in helminths of domestic and wild animals. It is apparently the first book of such proportions to present a well-rounded treatise of the subject of veterinary helminthology. It should not only serve as a well balanced textbook, but in view of its clear organization it will undoubtedly be a ready reference book for those who occasionally have need of specific information on various helminths.

The opening chapter is devoted to an introduction to the subject (history, types of parasites, immunity, etc.) and general discussions of the phyla and major classes of helminths. The generalized life cycles are presented along with the morphology of the various stages. Following the introduction there are seven chapters on the helminths of different hosts—horse, cattle, sheep and goat, swine, dog and cat, poultry, and fur bearers. The parasites of a given host are presented in a taxonomic order according to the classification of the three phyla (Platyhelminthes, Nemathelminthes, and Acanthocephala) as given in the introductory chapter.

Although the length of the discussions depends upon the importance of the parasite and the information available, the pattern of presentation is essentially the same for each. The more lengthy discussions generally hold to the following outline: synonyms, common name, disease, hosts, morphology, location, life cycle, symptoms, pathology, diagnosis, treatment, prevention and control, and general remarks. The general remarks usually include information on prevalence, distribution, and veterinary importance. It is evident on practically every page that there is a great deal not yet known about veterinary helminthology. The authors hope that the direction of attention to these gaps in our knowledge will stimulate investigators to find the needed information.

The last chapter outlines the various techniques for recovering and identifying helminths in fecal specimens, tissues, or blood. There is also a discussion of postmortem examinations of animals for parasites and evidence of their effect upon the host.

The book is profusely illustrated by clear outline drawings organized into 58 full-page plates. Although some of the plates give the generalized morphology and life cycles of the worms, most of them stress the diagnostic characteristics of eggs, larvae, and adults that are found in clinical material. Unfortunately, references to the figures are not made in the text. It is therefore frequently necessary to consult the index to determine if an illustration of the organism has been included. Five spot maps give the known locations of some of the parasites with a restricted geographical distribution in this country. All of the maps and most of the drawings are original. The appendix is reserved for a host-parasite list, and for references to books and publications dealing with veterinary helminthology. At the end of each chapter there is also a list of selected references.

M. M. BROOKE

ANIMAL GROWTH AND DEVELOPMENT

STRUCTURE AND DEVELOPMENT OF THE VERTEBRATES: *A Manual for an Integrated Course in Comparative Anatomy and Embryology. Prentice-Hall Animal Science Series.*

By Florence Moog. Prentice-Hall, New York. $3.50. xiv + 170 pp.; ill. 1949.

This book is primarily a laboratory manual designed to serve the needs of a course in which the usual subjects of comparative vertebrate anatomy and comparative vertebrate embryology are integrated into a single sequence. The book contains some textual material, but it is intended to be used in conjunction with standard textbooks of comparative anatomy and embryology. The manual was developed in connection with a course which the author has taught at Washington University for three years.

The first chapter introduces typical features of vertebrate form, as exemplified by Ammocoetes. The next two chapters are devoted to the early embryology of the frog and chick, respectively. Development through gastrulation and the assumption of body form is considered in these chapters, with emphasis on the study of models, whole mounts, and serial cross sections of various stages. The account of gastrulation in the chick follows those of Peters, Pasteels, and Spratt. A brief survey of the phylum chordata is presented in the fourth chapter, with emphasis on the evolutionary relationships of the different groups. A synoptic classification of the chordates is given at the end of the chapter.

Chapter five is devoted to a discussion of homology

and recapitulation. The role of embryology in establishing homology is emphasized. Recapitulation is interpreted in genetic terms, with emphasis on the role of gene mutations and competition among genes.

A system-by-system examination of vertebrates in both adult and embryonic stages follows, beginning with a consideration of the skin and its products. The general plan followed is to present material relating to embryonic development and to the comparative anatomy of adult forms in sequence in the same chapter, or group of chapters, devoted to a particular system. In connection with material relating to embryonic development, directions are given for study and drawing of sections and whole mounts of chick and pig embryos. For the study of the anatomy of representative adult forms, directions are given for dissection of the dogfish, *Necturus*, and the cat. The nervous system and sense organs are taken up last (chapter 17), which may be justifiable from a practical point of view but is not consistent with their developmental history.

Gametogenesis and fertilization are taken up briefly in chapter fifteen, apparently being introduced at this time to follow study of the urogenital system in chapter fourteen. Only prepared slides of sections through the oviduct of *Ascaris* are indicated for use in the study of fertilization. It is unfortunate that directions for the utilization of appropriate living material have not been included. The subject matter of this chapter would seem more appropriately to follow chapter one. The various types of placenta are considered in chapter sixteen. Included here are directions for dissection of a pregnant sow's uterus.

The figures are generally adequate but undistinguished. Many of them are photographs made from material in routine use in the author's laboratory. Directions for drawing and dissections are sufficiently detailed to minimize the work of laboratory instructors. Laboratory directions are distinguished from text by appropriate section headings. Directions for drawing are prefaced by the word "draw" in bold-face type.

The most important contribution made by this book is the attempt to integrate the laboratory work of comparative anatomy and vertebrate embryology into a scheme suitable for use in an integrated course. It is pertinent to note that Washington University is not the only institution in which these subjects are now being taught in one and the same course. This manual, furthermore, reflects the current tendency to reduce the amount of time devoted to presenting descriptive aspects of biology and is designed to lend itself to courses of 100 to 120 clock hours of laboratory work.

Obviously, whether an integrated course in comparative anatomy and embryology is more successful in meeting student needs than separate courses in these subjects will depend in large part upon the ability of the instructor to carry the integration to the conceptual level. This is considerably more difficult than the grouping together of laboratory exercises. It is, perhaps, to be anticipated that some so-called integrated courses will be nothing more than a topical sequence telescoped into one-half or two-thirds the time that would otherwise be devoted to covering the same material. This in itself may not be undesirable, but would be considerably short of the intent of the author of this manual. Teachers who are interested in developing an integrated course in comparative anatomy and embryology will no doubt find the present manual very helpful.

MAX KRAUSS

VERTEBRATE EMBRYOLOGY. *Third Edition.*

By Robert S. McEwen. Henry Holt and Company, New York. $4.90. xvi + 699 pp.; ill. 1949.

The third edition of this textbook remains primarily descriptive, but certain results obtained from experimental procedures have been included in the sections dealing with the Amphibia and Chick. With respect to the latter, for example, recent findings concerning gastrulation are described, evidence for and against homology of the chick primitive streak and amphibian blastopore is presented. A section on the development of the pig has been added. Literature references are given at the end of each section, and there is an index.

MAX KRAUSS

FUNDAMENTALS OF COMPARATIVE EMBRYOLOGY OF THE VERTEBRATES. *Second Edition.*

By Alfred F. Huettner. The Macmillan Company, New York. $5.00. xviii + 309 pp.; ill. 1949.

In preparing this second edition of his textbook Huettner has undertaken a fairly extensive revision of certain portions of the first edition. New material, including a chapter on the embryology of the pig, has been added. As was true of the first edition, the most notable feature of this book is the three-dimensional character of the illustrations. In this respect, Huettner's textbook remains in a class by itself. The format is excellent. No list of references is given. There is an index.

MAX KRAUSS

AN INTRODUCTION TO VERTEBRATE EMBRYOLOGY. *Second Edition.*

By H. L. Wieman. McGraw-Hill Book Company, New York, Toronto, and London. $5.00. x + 412 pp.; ill. 1949.

In revising his textbook, Wieman has made a number of changes, mainly directed toward providing additional descriptive material on the frog, human embryology,

and mammalian organogenesis. Some 40 new illustrations have been added. As in the first edition, the comparative point of view has been maintained. Certain aspects of experimental embryology, chiefly concerned with amphibian development, are briefly discussed in an appendix. This material might well have been given the status of a chapter. A short list of references, in connection with the appendix, is the only bibliography. There is an index.

MAX KRAUSS

LA SCIENCE DES MONSTRES. *L'Avenir de la Science—27.*

By Étienne Wolff. Gallimard, Paris. 580 fr. (paper). 265 pp. + 40 plates; text ill. 1948.

It is a peculiar and deplorable fact that no serious general treatise on teratology, the scientific study of monstrosities, has been published in the English language during the present century. With the exception of Schwalbe's encyclopedic work, which has shared the fate of many another German Handbuch of having become out of date before its final completion, the summarization of current knowledge has come almost exclusively from French writers: the two Saint-Hilaires, Dareste, Rabaud, and many others. To these is now added the present book by Étienne Wolff.

The author's aim was to write a survey, in simple language and for a wide audience, of the principal methods and problems of teratology. These aims, in part imposed by the fact that the book was written while the author was a prisoner of war, have been adhered to with great success. The result is a well illustrated text which lends itself admirably to an initial guidance through a complex and rapidly expanding field. The discussion is limited to vertebrate teratology. The original manuscript was completed in 1941, and an appendix was added in 1945. After a brief historical introduction, the book opens with a morphological account of the more common types of malformations. The first step in an analysis of malformations must always relate to their morphology, histology, and embryology. The author devotes one chapter to a presentation in these terms of selected cases, viz., ectromely, phocomely, anencephaly, coelosomy, and facial clefts. Wolff then gives a description of the techniques of experimental teratology. These are divided into *indirect* methods, applied to the egg or embryo as a whole, such as variations of the environmental temperature, mechanical shocks, or exposure to chemical agents, and *direct* methods, by which definite organ primordia are modified or eliminated with the aid of surgery and x-rays, transplanted to abnormal positions, or manipulated in other ways. One cannot agree here with the author's assumption that "indirect" methods necessarily produce their results by a modification of the general conditions of development, since there is evidence that their effects may be quite specific because of the selective susceptibility of particular parts.

The experimental production of twins and duplications is described in some detail. The following two chapters deal with various types of simple monsters, chiefly in chicken embryos, and with particular reference to the author's own beautiful experiments with x-rays. A negative aspect of the "direct" methods might have deserved some emphasis and discussion, namely, that they do not lend themselves to the production of teratological syndromes, such as are so generally brought about by genetic factors and environmental agencies.

The following chapter elaborates on the "laws of teratogenesis." Here there is much with which one cannot agree without strong reservations. Of these we can indicate but a few. According to the author's first law, the initial step of teratological development is always a localized arrest. There are too many exceptions to make this a safe generalization, e.g., the coexistence of duplications and defects in the "duplicate" mutation of the fowl, the possibility of inducing supernumerary organs (e.g., brain, Tamini), the effect of sex or other factors on the incidence of abnormalities, and so on. According to the author's second law, teratogenic factors act on the presumptive primordia between the moment of determination and that of differentiation. But there are cases in which an abnormality is known to begin during differentiation (insulin-induced micromelia) or even after its completion (brachymelia of rabbits); moreover, abnormalities may arise by a failure of determination to occur. Wolff's third law relates to the existence of differential susceptibility among embryonic tissues and is used to explain the origin of multiple abnormalities. It overlooks the fact that syndromes may arise because of differential needs of various parts, needs which in the presence of generalized metabolic disturbances cannot be met everywhere. Some other laws postulated by the author are less exceptional, but it is clearly too early to arrive at far-reaching generalizations concerning the universal origin of malformations.

Chapter 11 deals with spontaneous and experimental hermaphroditism, and chapter 12 with hereditary malformations. Additions in an appendix make it clear that at a later date the author would have discussed the problem of hereditary malformations differently and more extensively. A final chapter gives some general conclusions. Unhappily one cannot agree with the author that to know how to produce experimentally a particular malformation is tantamount to saying that its causes and mechanisms of formation have been explained. But such minor criticisms should not obscure the fact that the author has given us a very useful and valuable book.

WALTER LANDAUER

WOMAN'S INSIDE STORY.

By Mario A. Castallo and Cecilia L. Schulz. The Macmillan Company, New York. $3.00. xii + 203 pp.; ill. 1948.

A practising gynecologist and a nurse have pooled their experiences and talents in preparing this instructive and authoritative story of the development, structure, and function of the female reproductive system. Written in a clear, and simple fashion for popular consumption, the work is designed not only to impart knowledge, but to develop wholesome attitudes toward sex and the reproductive process. Particular emphasis is placed on the plea for women to give as much concern and care to their internal health or ailments as they give to their external appearance.

The discussions are centered largely around normal reproductive development and physiological activity from the time of conception of the individual, through fetal life to birth, and from thence through childhood, adolescence, and menarche, the reproductive span, the menopause, and on to senescence. Byways from this general scheme lead into detailed considerations of such topics as sterility, tumors, and pregnancy. Sufficient material on physiological abnormalities is included to give the average reader ample clues to the fact that some part of her reproductive system may need medical attention. Encouragement is given to the idea of routine physical examinations for health maintenance, in opposition to the idea that the doctor should only be seen when something goes wrong. Considerable effort has been expended to debunk many of the old wives' tales concerning pregnancy and child-birth and to tear down the barriers of fear and false modesty which have been largely responsible for keeping women "in the dark" concerning their own "inside story." A careful reading of the book would undoubtedly improve the outlook on life of countless women, of all ages from 16 to 60. A glossary and an index contribute much to the value of the work as a source of reference.

B. AUBREY SCHNEIDER

ANIMAL MORPHOLOGY

BIOLOGY OF THE VERTEBRATES: *A Comparative Study of Man and His Animal Allies. Third Edition.*

By Herbert E. Walter and Leonard P. Sayles. The Macmillan Company, New York. $6.00. xx + 875 pp. + 1 plate; text ill. 1949.

This book, now in its twenty-second year, has reached its legal majority—no mean achievement for a biological textbook. Unlike many people, the book retains most of the whimsical ways of its childhood.

As nearly everyone must know by this time, Walter's *Biology of the Vertebrates* is not a biology of the vertebrates. Nor is it the textbook of comparative anatomy that it superficially appears to be. It is designed quite frankly to ease young premedics into the work they will shortly be taking in medical school. It does an efficient and almost painless job, which doubtless explains its continuing popularity.

Sayles has reworked several of the chapters extensively, but the peculiar flavor of the earlier editions has been carefully preserved. More than half the illustrations have been redrawn and more fully and uniformly labeled, and many new illustrations have been added. Some will miss a few illustrations, like Raphael's cherubs and the cartoon-like "hatching dinosaurs," that may not have added much to the text but helped to lighten a subject that all too easily becomes dull and ponderous. The general format of the book has been modernized, and the page size slightly increased. So has the price. Many additional years of useful life may be predicted for this standard textbook.

D. DWIGHT DAVIS

COMPARATIVE ANATOMY: *An Introduction to the Vertebrates.*

By Leverett A. Adams and Samuel Eddy. John Wiley & Sons, New York; Chapman & Hall, London. $5.00. viii + 520 pp.; ill. 1949.

Many biologists maintain that comparative anatomy is moribund as a science, and that the only decent thing for it to do would be to expire peacefully and submit to a proper burial. D. M. S. Watson, himself a comparative anatomist of note, described comparative anatomy in the 14th edition of the *Encyclopedia Britannica* as "a term, now obsolescent. . ." Proponents of these views (not shared by the reviewer) will find potent support for their arguments in this textbook, which is no worse than others in the English language and better than many.

The authors divide the indivisible vertebrate body into the usual mutually exclusive morphological "systems," and then proceed to a dreary recital of facts—450 grim pages of them. The ultimate in fragmentation is achieved by dividing the description of each system into a series of air-tight compartments labeled, respectively, Fishes, Amphibians, Reptiles, Birds, and Mammals. It is inconceivable that a student could be inspired by such a parade of unrelieved and unrelated details.

What is wrong that we have so sorry a textbook in a field as old and mature as comparative anatomy? The book is reasonably accurate, profusely illustrated, and is supplied with a glossary and an index running to 28 pages each, and a bibliography. In physical appearance it is admirable, but as a presentation of the science of comparative anatomy it is a libel. The authors state (p. 105) that "comparative anatomy is a more dynamic approach to the study of anatomy than the mere learning of the location and structure of organs and systems," but this obviously crept in by mistake. Science is usually defined as the classification of facts *and the generaliza-*

tions derived therefrom. The present book is about as free of generalizations as is possible. Even homology, the broad generalization on which comparative anatomy is founded, is slurred over in two short paragraphs. Evolution, the most sublime of all biological generalizations, and indissolubly associated with comparative anatomy from the very beginning, is not even listed in the index! A science that is merely a recital of facts is not only dull and uninteresting; it is not even a science, but only the raw material from which a science can be built.

The few surviving comparative anatomists will probably weep alone at this travesty on their science. But the real impact of such tragically inadequate textbooks is on biological research as a whole. If generations of biological researchers—to say nothing of teachers of further generations—are to grow up in ignorance of the real meaning of comparative anatomy, then the whole framework of biological science is weakened by just that much.

What would be a good textbook of comparative anatomy? It surely would review the several outstanding contributions that comparative anatomy has made to biological theory. It would stress the intimate relations between structure and function that make comparative anatomy meaningful. It would be guided throughout by the important distinction between the biological and other sciences—the fact that living organisms, without exception, have been conditioned by the vicissitudes of their respective histories. Some biologists, in their zeal to get at the fundamentals of biology, forget this most fundamental of all biological facts. And finally it would remind the student, repeatedly, that comparative anatomy is not finished, but that important and exciting discoveries are still to be made.

There is no point in inveighing against geneticists, embryologists, physiologists, and others for failing to recognize that comparative anatomy is not dead. It is the comparative anatomists themselves who are responsible for the delinquency of comparative anatomy. I specifically charge this book with contributing to the delinquency of a science.

D. Dwight Davis

The Vertebrate Body.

By Alfred Sherwood Romer. W. B. Saunders Company, Philadelphia and London. $5.50. viii + 643 pp.; ill. 1949.

The teaching of comparative vertebrate anatomy has long suffered from the lack of a truly adequate modern textbook written in the English language. This statement is made with full cognizance that there are adequate and excellent textbooks in the traditional manner. But in these little or no attention has been paid to cognate sciences such as physiology, experimental embryology, and genetics, so that they are essentially anatomical or morphological in the narrower sense, too often in the moribund Gegenbaurian tradition. And, moreover, too many comparative-anatomical textbooks have been written by people who were not professionals in that field and who consequently have had no real knowledge of the true comparative method.

In the opinion of the reviewer, Romer has at last supplied us with a truly adequate book, in fact with a superior one that may play a considerable role in the rehabilitation of this branch of biology. As has been pointed out elsewhere, comparative anatomy, if it is to recover lost ground and to prosper, must become broader in scope—in fact, it must become a comparative biology in place of the narrower, traditional comparative anatomy or morphology. Romer's book meets this demand. In his introductory Apologia he lists six desiderata for the adequate comparative text: "1. Fairly adequate illustration. . . . 2. A truly comparative treatment. . . . 3. Proper paleontological background. . . . 4. A developmental viewpoint. . . . 5. Inclusion of histological data. . . . 6. Consideration of function." The body of the text reflects this point of view. The illustrations in general are first-rate, being neither too schematic nor overcrowded with details. The treatment of the body is truly comparative, human structure not being overemphasized but presented in its proper perspective. If the reviewer can find any fault, it is with the tendency toward an overemphasis of the reptiles, and to a less extent the fishes, with accompanying neglect of the amphibians. That there is proper and adequate paleontological background goes without saying, for the accomplishments of the author would guarantee that. If anything, one may feel at times that this aspect of the subject is a bit overdone—but every textbook necessarily reflects the interests of its author, and rightly so. Indeed, the presentation of the fossil evidence represents one of the most brilliant and stimulating aspects of the book. The embryology is comprehensive and takes cognizance of the contribution of the experimental method. That the included histology is largely mammalian merely reflects the gaps in our knowledge and at the same time points up one of the most promising fields for comparative study, especially if morphological methods are combined with those of physiology and chemistry. The frequent sections on physiology are concise, yet extraordinarily well done, and make amends for the "dead-house" treatment of the vertebrate body that is predominant in current courses on comparative vertebrate anatomy.

The book is so uniformly excellent that to single out separate parts is perhaps unjustifiable. But it may be noted that such subjects as "the homology concept," "adaptation and evolution," the relationship between ontogeny and phylogeny, "the germ layers," and nerve-muscle relationship receive wholly modern treatment without the lingering traces of Owenism, Lamarckism, Haeckelism, and Fürbringerism so often found in other

books. The chapters that deal with the skeleton are superior in quality. Those on the nervous system and the sense organs are among the best to be found in books of this sort. The muscular system, a subject that presents great difficulties of treatment and that is consequently badly dealt with or else grossly neglected in most comparative-anatomical texts, is handled, for the most part, with great skill—which reflects Romer's recognized status as an outstanding comparative myologist.

It has been a great pleasure to review this book. For, in the opinion of the reviewer, it is without serious defects. To dwell upon its minor errors and its treatment of certain controversial points would be to cavil, indeed. It is not only authoritative, but well written and easy to read, in addition. It should go a long way toward advancing the cause of comparative biology in this country.

WILLIAM L. STRAUS, JR.

BENSLEY'S PRACTICAL ANATOMY OF THE RABBIT: *An Elementary Laboratory Text-Book in Mammalian Anatomy. Eighth Edition.*

Revised and edited by E. Horne Craigie. The Blakiston Company, Philadelphia. $4.25. xii + 391 pp.; ill. 1948.

A number of small changes and additions have been made in the present revision of this well-known elementary laboratory textbook on the anatomy of the rabbit. Among other additions, there is a new section on fetal circulation. The chapter on General Anatomy and the section on the description of the larynx have been expanded a little. Some new illustrations have been added and some old ones replaced by new photomicrographs.

DAVID B. TYLER

COLLATERAL CIRCULATION: *Anatomical Aspects.*

By Daniel P. Quiring; illustrated by Margaret Holman. Lea & Febiger, Philadelphia. $5.00. 142 pp.; ill. 1949.

Quiring here presents the anatomy of the arterial and venous bypaths that develop on occlusion of major vessels, and reviews certain aspects of their physiology. In so far as the book describes the topography of these vascular pathways, it is concise and well-informed, but where it becomes theoretical it is frequently poorly digested and unclear.

The book consists of 128 pages of text and excellent illustrations, plus a carefully selected bibliography and a good index. The contents include a brief historical review that shows clearly how much of the work on circulation is not modern; a descriptive embryology relating how primitive vascular networks become differentiated in the early development of the individual; a discussion of vascular dynamics; and a well conceived regional presentation of the major collateral pathways, both arterial and venous.

The material is presented in such form that specific information can be located easily, and there are no large gaps in either the classical or recent descriptions of collateral routes. The inclusion of recent information is well typified by the generally excellent treatment of the collateral coronary circulation. Practical illustrative material is inserted from time to time. The unusually readable type, clear illustrations, and pleasant format are also deserving of comment.

In general, where the literature is reviewed, the author has failed to correlate information in the papers of various writers and has presented insufficient material to provide a basis of judgment for the reader. Certain physiological concepts are confusingly presented. As a specific example, the limitations in the applicability of the 4th power law (Poiseuille's law) are not made clear, despite the fact that this principle holds only for small tubes where the viscosity of the contained fluid is an important factor in the rate of flow. It is unfortunate also that the various concepts of the term "end artery" are not defined. *Collateral Circulation* should prove to be a useful reference book for anatomists and surgeons, and in addition it is interesting enough to attract students and should attain a considerable popularity.

E. CONVERSE PEIRCE, 2ND

SURGICAL TECHNIQUE AND PRINCIPLES OF OPERATIVE SURGERY. *Fourth Edition.*

By A. V. Partipilo; foreword by Alton Oschsner; original illustrations by W. C. Shepard and Hooker Goodwin. Lea & Febiger, Philadelphia. $15.00. 676 pp.; ill. 1949.

Surgical Technique, as presented by Partipilo, is well grounded in the basic disciplines of anatomy, pathology, and physiology, but despite its stated purpose to provide a "practical reference text for the surgeon," it constitutes primarily an approach to surgery for the student. There is great emphasis on fundamentals of technique, with chapters on suture material and knot-tying. Anatomy is well represented, with individual sections devoted to the abdominal wall and the peritoneal cavity.

In general, the book is more restricted than most textbooks of operative surgery. The author has provided thirty chapters on general principles, the stomach, duodenum, small intestine, breast, and thyroid gland, and some of these subjects have been given disproportionate emphasis. The remaining twenty-three chapters, by eight authors, cover the thorax, biliary pas-

sages, large bowel, anus and rectum, kidney, peripheral vascular disease, facial injuries, and blood transfusions. There are many large gaps, and much of the material not written by Partipilo is too briefly covered to be of use to any but the casual reader. It is unfortunate also that the most complete chapters have the best bibliographies, while the briefest have none. Cardiac surgery, for instance, is dispensed with in four pages without references, though the twenty-one page chapter on duodenal obstruction has fifty-one references.

The main body of the book is well written and sensible. Generally only one surgical method is presented in detail. The text is greatly enhanced by the unusually fine line drawings of W. C. Shepard and Hooker Goodwin. Partipilo's book can be highly recommended to students and practitioners seeking an approach to surgery, but it will prove a disappointment to those who desire a complete coverage of the field.

E. Converse Peirce, 2nd

ANIMAL PHYSIOLOGY

Respiratory Enzymes. *Second Edition.* *By Laurens Anderson, Robert H. Burris, Phillip P. Cohen, C. A. Elvehjem, M. J. Johnson, Henry A. Lardy, G. A. LePage, Henry Little, R. W. McGilvery, W. H. McShan, G. W. E. Plaut, Van R. Potter, W. C. Schneider, and P. W. Wilson; edited by Henry A. Lardy. Burgess Publishing Company, Minneapolis.* $4.50. iii + 290 pp.; ill. 1949.

This is an excellent textbook covering the subject of the respiratory enzymes and, like the first edition, will be of special interest to the investigator in the field of enzymology. In essence, this revision was made in order to include the most recent developments in the field and to delete much that has become obsolete. The text opens with an excellent historical treatment of the subject (C. A. Elvehjem), and is followed by sections dealing with such subjects as the Kinetics and Mechanisms of Enzyme Reactions (P. W. Wilson); Oxidation-Reduction Potentials (Marvin J. Johnson); Table of Oxidation-Reduction Potentials (Laurens Anderson and G. W. E. Plaut); Coenzymes and Activators (G. A. LePage); Dehydrogenases (W. H. McShan); Cytochrome Systems (Van R. Potter); Oxidases, Peroxidases, and Catalase (R. H. Burris and Henry N. Little); Glycolysis (Henry A. Lardy); The Citric Acid Cycle and the Cyclophorase System (David E. Green); Enzymatic Systems Concerned with the Metabolism of Certain Nitrogen Compounds (Phillip P. Cohen and Robert W. McGilvery); Energy Relations in Metabolic Reactions (Marvin J. Johnson); The Control of Metabolism (Van R. Potter); and the Distribution of Enzymes Within the Cell (Walter C. Schneider).

David B. Tyler

Manometric Techniques and Tissue Metabolism. *By W. W. Umbreit, R. H. Burris and J. F. Stauffer; chapters on specialized techniques by P. P. Cohen, G. A. LePage, V. R. Potter, and W. C. Schneider and contributions by J. A. Bain, D. E. Green, H. A. Lardy, A. L. Lehninger, R. W. McGilvery, and R. Wennesland. Burgess Publishing Company, Minneapolis.* $4.00. v + 227 pp.; ill. 1949.

This edition of this useful and practical manual is a considerable improvement over the first. It has been very extensively revised and rearranged, and many new figures and charts have been added. The tables have been reset, improving not only their appearance but also their readability. As in the first edition, there will be found chapters on Specialized Techniques by P. P. Cohen, G. A. LePage, V. R. Potter, and W. C. Schneider. Other contributors to this edition are: J. A. Bain, D. E. Green, H. A. Lardy, A. L. Lehninger, R. W. McGilvery, and R. Wennesland. The chapters on chemical and special methods have been expanded to include a number of new and valuable techniques which have recently been developed. A short section on the use of isotopic tracers in the Warburg apparatus has been included, with suggestions as to how such procedures may be applied to the study of enzymatic reactions. However, since it fell outside the scope of this book, no detailed consideration has been given to the instrumentation and techniques involved in the use of isotopic tracers. An extensive section by R. Wennesland, describing volumetric apparatus for the study of tissue metabolism, and one by D. E. Green on the preparation of cyclophorase have been added to this edition. There is also an entire new chapter by W. C. Schneider on the isolation of particulate components in the cell. Practically all of the chapters have been very thoroughly revised, and the book is now bound with a hard, durable cover which will improve its usefulness in the laboratory. For subsequent editions, it is suggested that the index be expanded to include an author's index. This manual will undoubtedly be a valuable addition to the personal library of all those who are interested in problems of tissue metabolism. It will also serve as a laboratory companion to *Respiratory Enzymes*, reviewed in this journal on p. 97.

David B. Tyler

A Textbook of Physiology. *Sixteenth Edition.* *Edited by John F. Fulton; with the collaboration of Donald H. Barron, John R. Brobeck, Robert W. Clarke, George R. Cowgill, Paul F. Fenton, William U. Gardner, Samuel Gelfan, David I. Hitchcock, David P. C. Lloyd, Leslie F. Nims, Theodore C. Ruch and Jane A. Russell; originally by William H. Howell. W. B. Saunders Company, Philadelphia and London.* $10.00. xl + 1258 pp.; ill. 1949.

This volume in its 16th Edition (the second revision by John Fulton and his collaborators) ranks among the very few truly excellent physiological textbooks. Since this edition, compared with the 15th published 3 years ago, has been rather extensively revised and rewritten, this review will deal with major changes. The 15th Edition has been adequately reviewed in Q. R. B. *21:* 200. 1946.

The text is now divided into thirteen principal divisions, instead of the ten found in the 15th Edition. The most extensive addition is the inclusion of a much needed division on Endocrines, prepared by Jane Russell. A separate division on Muscle has been prepared by Samuel Gelfan, thus leaving to David Lloyd the responsibility for the chapters dealing with the principles of nervous activity. (In the 15th Edition, Lloyd covered both Muscle and Nerve.) Another addition is a contribution by T. C. Ruch on the Urinary Bladder. The division on the Central Nervous System has been shortened by about 40 pages through deletion of obsolete material, both in text and illustrations. J. R. Elkinton has rewritten the chapter on the Kidney, and R. B. Livingston has contributed a section on the Cerebrospinal Fluid. The chapter on the genetic aspects of physiology has been dropped. In preparing this edition there has been some departure from the simple and lucid style of Howell. Nevertheless, the book is still one of the very few major textbooks suitable for use by advanced students of physiology.

DAVID B. TYLER

AN INTRODUCTION TO GASTRO-ENTEROLOGY. *Fourth Edition.*

By Walter C. Alvarez. Paul B. Hoeber, Medical Book Department of Harper & Brothers, New York. $12.50. xxiv + 903 pp.; ill. 1948.

Since 1922, *An Introduction to Gastro-Enterology* has been the standard source book in its field, and deservedly so. This edition maintains the standard set by the three previous ones. The bibliography has been increased by twenty-five per cent, to include 2800 titles. The subjects most extensively modified are those concerned with the innervation of the gastro-intestinal tract, the functions of the colon, the electro-enterogram, and with technical methods and apparatus. In all of this, the hand of an old master in the field is evident. The reader knows that the evaluations made are the result of a very extensive laboratory and clinical experience indeed.

The mark of the earlier editions is still very evident. From the outset, and recurrently, the subject of the existence, mechanism, and functions of gradients of intestinal activity are assessed and stressed. It is the dominant theme in the discussion of normal and abnormal intestinal activities. The author has drawn heavily upon ancillary fields in biology in efforts to clarify all points. This is stimulating to the inquisitive reader, and it challenges the imagination. One recognizes over and over again how elusive a thing an absolute understanding of a biological function is! To explain one process by a similar process involves a semantic tautomerism which leaves one wondering. What is the beginning and where is the end?

The volume is large, well-printed, and handsomely illustrated. Only the index is brief and inadequate. The inclusion of photographs of numerous workers, past and present, who have made important contributions in the field is, one feels, incomplete: modesty forbidding the inclusion of a picture of Alvarez himself. This volume is so extensive, so sound, and so valuable that the reader will feel he has been denied a privilege in not seeing in this gallery the author's picture along with the rest.

S. R. M. REYNOLDS

SECRETION OF MILK. *Third Edition.*

By Dwight Espe. The Iowa State College Press, Ames. $3.50. viii + 314 pp.; ill. 1946.

This book represents fifteen years' collection of material for the teaching of a college course in milk secretion. A very large amount of information is presented in brief form. The book consists of three parts. The first part covers the phylogenesis of the mammary gland and the anatomy of the udder. The author is very modest, stating in the preface that he "may have failed to grasp the true significance of the work which has been reported." His point of view is obviously that of a searcher among the research results of the physiologist, anatomist, and nutritionist for facts which may be pertinent in understanding why and how cows secrete milk. The narrowness of the account is somewhat exaggerated by the author's not wholly acceptable statement: "The mammary glands of many mammals, especially domesticated mammals, are interesting from a scientific view, but in America at the present time the practical importance of the milk of the cow makes a knowledge of her udder more important than an understanding of that of any other species."

Part Two consists of four chapters. The chapter on nervous control of milk secretion is rather confusing. The chapter on the factors affecting the amount and composition of milk, including the effects of age, season, reproductive state, and inheritance is well done. The review of hormonal control of milk secretion is lucid and effective. Espe properly concludes, however, that "the practical significance of the many recent discoveries in endocrinology can only be surmised." The third part of the book summarizes research on the effects of feed on the amount and composition of milk. The literature cited consists of 1294 titles.

T. C. BYERLY

ENDOCRINOLOGIE DES ARTHROPODES. *Colloques Internationaux du Centre National de la Recherche Scientifique, IV. Paris, Juin 1947.*

Centre National de la Recherche Scientifique, Paris. 1000 fr. (paper). 213 pp. + 1 plate; text ill. 1949.

This report on the International Colloquium on the Endocrinology of Arthropods, held in Paris in June, 1947, and published as Supplement XXXIII to the *Bull. biologique de France et Belgique*, contains the following papers: The Retrocerebral Endocrine Glands of Insects (Cazal); The Hormonal Control of Moulting and Metamorphosis in Insects (Wigglesworth); Determinism of Metamorphosis in Lepidoptera (Bounhiol); The Endocrinology of Diapause (Williams); The Reactions of Crustaceans to Insect Hormones (M. Thomsen); An Experimental Study of the Metamorphosis of *Sialis lutaria* L. [Megaloptera] (Geigy); The Gonadotropic Hormones in the Diptera (E. Thomsen); The Sexual Hormones of Insects (Joly); The Chemistry of Insect Hormones (Timon-David); Brain Centers and Incretory Organs in the Head of Crustacea Malacostraca (Hanström); Migrations of the Retinal Pigments and Their Regulation by the Sinus Gland (Kleinholz); Colour Change and Colour Hormones in Crustaceans (Carstam); The Problem of the Number of Hormones Concerned in the Pigment Movements of Crustaceans (Knowles); The Sinus Gland and the Maturation of Genital Products in Shrimps (Panouse); The Sinus Gland, Moulting, and Metabolism in Crustaceans (Drach); General Report on the Endocrinology of Insects (Wigglesworth); General Report on the Endocrinology of Crustaceans (Drach); and Three Principal Incretory Organs in the Animal Kingdom (Hanström).

THE ADRENAL GLAND.

By Frank A. Hartman and Katharine A. Brownell. Lea & Febiger, Philadelphia. $12.00. 581 pp.; ill. 1949.

This book is a timely and substantial compendium of research on the adrenal gland. The authors have attempted to treat all phases of the subject. To summarize a field as active as that of the adrenal, which at present seems to be exploding in all directions, is indeed an ambitious task. The book includes some discussion of the anatomy, histology, development, biochemistry, physiology, pathology, and diseases of the adrenal, with chief emphasis on physiology. Of thirty-four chapters, six are concerned with epinephrin and medullary function, thirteen with the physiology of cortical function, chiefly in relation to electrolyte and water exchange, energy metabolism, and endocrine interrelationships, and eight with adrenal diseases. It contains an impressive bibliography of well over 3000 references, but no date on which the bibliography was closed. The material has not been particularly well organized, treatment is sometimes perfunctory, and not free from contradictions. It does not present any outstanding syntheses, nor on the other hand any pretentious guess work. It does constitute an assemblage of the outcome of a vast number of physiologist-hours, and will be useful as a work of reference for the specialist. However, the treatment of any subject is seldom intensive enough to be more than a first approach to it. In effect, the book has not surmounted the contemporary Sturm und Drang in endocrinology, which as many of us believe, can probably only be ordered in a satisfactory and enduring sense by the gradual development of a theoretical chemistry of life processes.

As a conscientious summation, this is of necessity a book which faces largely toward the past—a past where physiology has been hewing the wood and drawing the water of primitive first approximations, rather than toward the future of an adrenal physiology attuned to the music of the molecules.

EVELYN HOWARD

ELECTROCARDIOGRAPHIC TECHNIQUE. *A Manual for Physicians, Nurses and Technicians.*

By Kurt Schnitzer. Grune & Stratton, New York. $3.50. 96 pp.; ill. 1949.

This little book deals exclusively with electrocardiographic technique, and is intended particularly for the technician not trained in the field of electrocardiography. The manual covers the following topics in a clear and concise manner: The Human Heart; The Electrocardiographic Machine; The Electrocardiographic Room and Preparation of the Patient; The Recording of the Electrocardiogram; The Standardization of Precordial Leads; Special Procedures and Devices; Distortion of the Electrocardiograph and its Elimination; Finishing of the Record; and Mounting and Filing. Although there is no attempt to instruct the reader in the interpretation of records, some consideration is given to a few patterns that can be mistaken for artefacts. The style of writing is simple and lucid. It is excellently illustrated with original drawings and photographs and contains an adequate bibliography and index. This sound little book should prove a very useful addition to the personal library of nurses and technicians.

DAVID B. TYLER

DIE ELEMENTE DER NERVÖSEN TÄTIGKEIT.

By A. E. Kornmüller. Georg Thieme Verlag, Stuttgart. RM 13.50 (paper). viii + 120 pp.; ill. 1947.

This review monograph is an interesting attempt to correlate the structure and chemical constitution of nervous tissue with its functional activity. Principal attention has been given to the "neurone theory" and the synapse problem, and various points of view are

presented. As in all previous attempts to reconcile the findings and concepts of the "neuronists," who see no evidence of any continuity of neurofibrils from cell to cell in synaptic areas, and of those who advocate a syncytial doctrine of nerve cell, and neuroglial, structure, the choice is finally made well to one side of the middle. A novel twist is added, however, in that neurofibrils are represented as showing discontinuity, but as ending, nevertheless, *within* the cell of termination. Unfortunately, original evidence for the intracellular location of the synapse is not offered, nor is the evidence of the older syncytialists marshalled in a convincing way. In the reviewer's opinion, however, credit is due the author for giving the non-neuronal elements of the nervous tissue more attention than is customary, although a really useful working hypothesis of their function does not appear to be offered.

DAVID BODIAN

CHEMICAL INSECT ATTRACTANTS AND REPELLENTS. *By Vincent G. Dethier. The Blakiston Company, Philadelphia and Toronto.* $5.00. xvi + 289 pp.; ill. 1947.

The main purpose of this book is to bring together from a scattered literature in several fields the information which will contribute to an understanding of the chemical, physical, biological, and physiological factors which underlie the effectiveness of attractants and repellents. For its contributive significance in relation to this purpose much information has been furnished regarding the substances and devices that contribute to insect control, and those to whom these aspects are of primary concern are referred to the several detailed discussions of these matters. Similarly, although chemoreception is the fundamental basis underlying the stimuli and responses involved in the action of attractants and repellents, the book is not intended as a comprehensive treatment of chemoreception per se. Rather, the book effectively furnishes a comprehensive insight into insects' chemoreception as fundamental behavior on which practical procedures and further research may be based. As a result, the author's main purpose is achieved with notable success, and the book is a highly enlightening, interpretive, and stimulating volume of far wider interest and significance than its title might indicate.

It is clear that the author hopes that better understanding of the basic aspects of attractants and repellents will contribute to the knowledge of insect behavior and ecology, and even to a better understanding of the evolution of certain of their habits and behavior patterns. It is clear also that the author hopes that the book may lead to work that will contribute to our knowledge of the host-parasite relations and food-plant preferences of insects, and also to a fuller understanding of the bases of physiological races among the insects. Within the 289 pages of this compact book are contained the interpretation and evaluation of a tremendous amount of significant but scattered literature, together with much original work by the author, whose outstanding contributions in the investigation of the essential bases of selection of food plants by insects preeminently qualifies him to write this treatise.

In type and format the book is attractive. The illustrations are excellent and effectively supplement the text. Since the chapters cover fields which are necessarily diverse, although essential to the fundamental plan of the work, the lists of pertinent literature are placed at the end of each chapter. While this arrangement inevitably involves some repetition, it is highly helpful to the reader.

The general plan of organization followed in the book is an effective one. After a Preface of 2½ pages in which the objectives and the fundamentals of the book are set forth, there is a brief Foreword by Professor Brues, emphasizing the extensive ramifications and the significant implications to be derived from the basic physiological theme of the relation of the senses of smell and taste to the behavior of insects. The first chapter, after a historical background and a definition of the terms attractant and repellent, points out that the stimuli involved are fundamentally chemical in nature. The major types of physical stimuli are then briefly discussed in their relation to these. In the second chapter, the nature of chemical attractants is considered in detail. Here is clarified the fundamental fact that odors alone are involved in the chemical attractants, while both odors and tastes may serve as repellents, through calling forth simple avoiding reactions. Although this chapter emphasizes the two great classes of attractants, those which direct the insect to suitable sites for laying eggs and those which direct it to its food, there are also excellent discussions of other attractants, such as the sex scents which result in spectacular assembling, and the recognition odors so important among social insects. After a comprehensive consideration of the attractants for oviposition, there follows a survey of the attractants which direct insects to their food, with a discussion of the classificational schemes by which insects may be grouped according to their feeding habits. Finally, the author notes the three well-defined groups into which the chemical food type of attractants falls, and briefly outlines these as the categories which are to be examined in detail in the three comprehensive chapters that follow.

Chapter 3, on the essential oils, resins, and related substances which are the fundamental plant products attracting insects that feed on leaves, flowers, fruits, wood, and sap, is a highly effective treatment of 35 pages, with a summarizing discussion and extensive bibliography. Here is brought together the pioneer work of the author himself and of other investigators of this fascinating field, work that effectively substantiates the final conclusion that the so-called botan-

ical sense of insects, which governs their relation to certain taxonomic groups of plants, basically depends on the presence of these substances.

Chapter 4 discusses in detail the products of fermentation, such as alcohols, acids, aldehydes, esters, and carbinols, which direct the carpophagous, xylophagous, mycetophagous, and sap-feeding insects. Information of a fundamental chemical nature explains the basis of the attractants for such destructive insects as the fruit moths and fruit flies, the codling moths and borers. The discussion brings out the interesting points that insects attracted by products of fermentation are not rigidly specific in their feeding habits, and hence that many insects whose life activities have no relation to natural fermenting materials may be lured by such attractants. It further clarifies the fact that products of fermentation serve primarily as feeding-type attractants, and serve secondarily, and for relatively few insects, as attractants for suitable sites for egg-laying.

Chapter 5 (36 pages) furnishes a detailed discussion of the fundamental products of protein and fat decomposition, emphasizing the fatty acids, amines, ammonia, carbon dioxide, and other products which attract many types of insects to diverse decaying natural substances. Chapter 6 furnishes a very valuable survey of the work which has been done by means of olfactometers to determine with precise quantitative accuracy the attractive or repellent properties of various materials. The discussion of the advantages and disadvantages of various types of olfactometers gives helpful understanding of experimental procedures by which dependable information has been obtained, and furnishes the investigator with the understanding and implementation on which such work must be based. While this chapter is especially useful for the research worker, yet it is also of general value in furnishing the fundamental knowledge and understanding on which an evaluation of such work must depend. Chapter 7, in its interpretive consideration of baits and traps, contrasts the empirical procedure of testing hundreds of miscellaneous chemical compounds with the more logical procedure of applying the fundamental principles of an understanding of chemoreception in insects to obtain more effective practical results. The importance of the feeding-type of attractants is stressed, as is the importance of investigating those types of compounds which meet the preference of insects for certain molecular combinations and concentrations; and the relation of these more fundamental factors to specific problems in trapping is effectively exemplified.

Thus the major part of the book is concerned with attractants. It remains for Chapter 8 to consider (in 31 pages) the problems involved in repellents, chiefly of the chemical type. The application of these to insects which are blood-sucking, disease-carrying, crop- or product-destroying or otherwise noxious is effectively set forth with a wealth of fundamental material on which the application of repellents must be based. Chapter 9, on the chemical basis of taste and olfaction, is a fundamental and significant one in its analysis of what has been contributed to an understanding of the chemical basis of taste and odor, while the final chapter summarizes and evaluates the work that has been done toward interpreting the evolution of feeding preferences among certain groups of insects.

The exacting standards of the author are reflected in the absence of even minor errors. The only product of typographical fermentation acting as an attractant to your reviewer is the startling word "arattctant," which, even though it comes at the very beginning of an excellent paragraph on the definitions of terms, proves more disconcerting than misleading.

An extensive author index is not only useful in itself but also gives a convenient means of locating the many valuable references assembled at the ends of the various chapters. Included here are authors mentioned only in the references, the listing of Osterhout, for example, referring to the paper by him in the literature references of Chapter 9, the work itself not being specifically mentioned in the text. The detailed subject index, comprising 19 pages, contributes to the utility of the book.

The two aspects of the work which impress this reviewer particularly are first, the diverse and numerous aspects of biology, in its broadest sense, on which the contents of this book have significant bearing; and second, the wealth of fascinating problems which positively plead for investigation as a result of the provocative questions brought up in every chapter of this stimulating book.

W. H. WESTON

THEORY OF HEARING.

By Ernest Glen Wever. John Wiley & Sons, New York; Chapman & Hall, London. $6.00. xiv + 484 pp.; ill. 1949.

The author has divided this book into three sections. The first section presents an historical treatment of the classical theories of hearing, from the days of the Greek philosophers up through the early part of the twentieth century. The second section deals with the modern developments of these theories, and includes some of the anatomical and neurophysiological data pertinent to these developments. The third, and largest section, presents the author's own theory, and relates his theory to the neurology and psychophysical data of hearing.

The history of auditory theory is an excellent presentation, and should be required reading for all students in the field of hearing. The development of the sequences of ideas, and the relatedness of various theories is very well handled. Likewise, when the author is dealing with factual data in the area of anatomical and neurophysiological data, he is at his best. When,

however, the author presents his own theory of hearing, and relates it to present information, the reviewer finds plenty of cause for complaint.

Theories of hearing have usually been much more concerned with the problem of pitch perception than with the problem of loudness perception, partly because it has seemed much easier to explain loudness perception. These theories have in general taken two directions. The place theories explain pitch perception as being due to a different locus of stimulation in the cochlea with different frequencies. Frequency theories, on the other hand, have explained pitch perception as being due to the representation of the frequency of the stimulus in the frequency of neural impulse. In Wever's own theory, which he calls the Volley Theory, he combines these two seemingly opposed theories into one. According to him, the pitch of low tones is mediated only by frequency representation in the neural discharge. Since any single neuron cannot respond at a rapid enough rate by itself, the author resorts to a volley principle, in which it is assumed that various neurons respond at synchronized but staggered rates in such a way as accurately to represent the frequency of stimulation. The pitch of high-frequency tones is determined by a place representation in the cochlea. Intermediate-frequency tones (400 to 5000 cps) have both place and frequency representation.

From the presentation of anatomical and physiological evidence, the reviewer had the impression that the facts favor a straight place theory more than the Volley Theory. There is plenty of evidence that low tones have differential place representation in the cochlea, and in higher neural centers as well. Since place representation does occur, it is difficult to see why resort to a frequency principle is necessary. On the other hand, the facts also show that there is frequency representation up to about 4000 cps in the auditory nerve, but there has never been evidence that the frequency representation holds in higher neural centers. There is no question of the fact that there is some form of frequency representation in the neural discharge, but the question remains: Does this frequency representation have anything to do with pitch perception *per se*? In the reviewer's opinion, the author has not proved his point satisfactorily.

In many cases, there are facts which are difficult for both place and frequency theories. However, the author tends to treat these facts as being in favor of his theory because they are not satisfactorily handled by a place theory. In this connection it should be pointed out that the author usually requires the facts to be explained by a simple, high-resonance kind of place theory, which nobody believes today anyway. The evidence is clear that there is no discrete resonance, in the sense that only one fiber of the basilar membrane is activated for a particular pitch. Modern place theories, however, do not assume such discrete resonance, and the facts are much more easily explained without this assumption.

As an example, Neff's work on partial sectioning of the eighth nerve showed that high tone deafness usually results, and that low tones are rarely disturbed until complete deafness. It is true that this is difficult to explain with a place theory, but it should cause the Volley Theory equal difficulty. Since, according to the Volley Theory, low tones involve neurons from almost the entire cochlea, then *any* loss of neurons should affect sensitivity for low tones. On the other hand, since high tones involve only small specific groups of neurons, sensitivity to them should be affected only when those specific fibers are cut. Yet the author uses these data as evidence for his theory.

In another instance, the author cites the fact that differential pitch sensitivity requires a relatively constant number of cycles per second at low frequencies, but a relatively constant ratio of cycles per second at high frequencies. The integrated difference limen function agrees quite well with the pitch function, and fairly well with data on loss of sensitivity with lesions on different parts of the cochlea. And yet the author uses the fact that a relatively constant number of cycles is required for differential sensitivity at low frequencies as support for his theory, because "it is reasonable to find a differentiation that is constant or nearly so in terms of cyclic change." Why this assumption is reasonable is not explained, and it is difficult to accept when we recall that differential sensitivity in nearly all areas of sensation is a relative matter. Also, the author explains loudness as being represented by the total rate of neural discharge, and yet he does not expect the difference limen to be represented as a constant number of additional units of discharge. This kind of reasoning seems too opportunistic.

In another instance, the author finds it convenient to explain away a fact that cannot fit his assumption of frequency representation. The intensity-pitch relation shows that the pitch of low tones becomes lower with an increase in intensity, and that of high tones becomes higher. This relation, particularly for low frequencies, is very difficult for a theory which requires exact frequency representation. And we find, according to the author, that the change is not really one of pitch, but rather a kind of general confusion. As one who has experimented on the pitch-intensity relations, the reviewer would like to insist that the difference is one of pitch, and not confusion.

In a chapter on tonal interactions, the author finds that place theories have a great deal of trouble explaining beats and difference tones. This difficulty is due only to the straw man of discrete and narrow resonances which the author sets up. Modern place theories have no difficulty with these problems, when distortion in the middle ear is assumed (and such distortion is demonstrated in the cochlear microphonics shown by the author), and when overlapping areas

of stimulation on the basilar membrane are allowed. Likewise, in a later chapter on temporal phenomena, in discussing amplitude modulation effects, the author states that as the rate of modulation increases, the ear "gives . . . a whole series of transition phenomena that our mathematics provides no reckoning of." Such a statement is true only if infinitely narrow resonance units are assumed, and again we state that such an assumption for place theories is not necessary, nor is it done. A series of adjacent electric filters can be set up which will give all the transition phenomena which are found in the human ear, and it is quite unnecessary to assume a frequency representation.

In this same chapter, the perception of interrupted tones is discussed, and the author points out that a tone corresponding to the rate of interruption *can* be heard. Such a tone should be heard according to a frequency principle, but when such tones are heard they are very faint. Such faint tones can be easily explained as the products of the non-linear distortion in the middle ear. Also, the sideband components generated with interrupted or amplitude-modulated tones can be distinctly identified with the use of a probe tone to generate beats. These phenomena occur at low frequencies as well as high frequencies, and are far better explained on the assumption of a place analysis than on the assumption of frequency representation.

In conclusion, it is the reviewer's opinion that this would have been an excellent book if the author had had a better theory of hearing to work with. Too many of the facts of hearing have trouble being explained by a frequency principle, and the constant attempt of the author to use such an explanation in the book detracts from its value as a sourcebook of information on the theories of hearing, or for information on the neurophysiology of hearing. If the theoretical arguments were taken out of the book, the remainder would still be an excellent and scholarly review of facts well worth the reading by anyone interested in the general field of hearing.

W. R. GARNER

DOCUMENTA OPHTHALMOLOGICA: *Advances in Ophthalmology. Volume III.*

Edited by F. P. Fischer, A. J. Schaeffer, and Arnold Sorsby. Dr. W. Junk, 'S-Gravenhage. Fl. 36.00. 328 pp. + 3 plates; text ill. 1949.

This volume contains most of the papers which were read at the conference on colour vision held in Cambridge, England, between July 28th and August 2nd, 1947. The contributors, and the titles of their papers, are: The Present Status of the Trichromatic Theory (W. D. Wright); Retinal Structure and Colour Vision (S. Polyak); The Laminar Pattern of the Lateral Geniculate Nucleus Considered in Relation to Colour Vision (W. E. Le Gros Clark); The Analysis of Retinal Elements by the Micro-Electrode Technique (R. Granit); The Photochemistry of Vision (G. Wald); Increment Thresholds and the Mechanisms of Colour Vision (W. S. Stiles); The Polychromatic Theory (H. Hartridge); Colour Vision in the Central Fovea (E. N. Willmer); Colour Discrimination and the Influence of Colour Contrast on Acuity (D. L. MacAdam); Colour Recognition of Very Small Light Sources (J. G. Holmes); Current Views on Colour Blindness (D. B. Judd); Brightness, Visual Acuity and Colour Blindness (S. Hecht); Some Aspects of Anomalous Vision (F. H. G. Pitt); Phenomena Observed in Veiled Colours (S. Kraus); Chromatic Aberration of the Eye (A. Ivanoff); The Two-Quanta Explanation of the Dependence of the Threshold Values on the Visual Angle and the Time of Observation (M. A. Bouman and H. A. van der Velden). This list of contributors is an almost complete roster of the world's foremost color vision scientists.

Although a volume such as this could hardly be expected to be as closely integrated as a textbook, the papers are all concerned with such a specific topic that collectively they present an excellent summary of the status of our knowledge about color vision. Some of the contributors have chosen to present recent experimental data, others have summarized the literature on specific topics, and the remainder are mainly theoretical in nature. The volume is highly technical and is concerned with a highly specific subject but it will be an important addition to the library of the visual scientist.

A. CHAPANIS

ANIMAL NUTRITION

ENSEIGNEMENTS DE LA GUERRE 1939–1945 DANS LE DOMAINE DE LA NUTRITION. *Médecine et Biologie, Number 6.*

Edited by E. J. Bigwood. Masson & Cie., Paris; Editions Desoer, Liège. 760 fr. (paper). 470 pp. + 3 charts; text ill. 1947.

This volume contains the papers presented in a symposium on nutrition during the war period, under the presidency of Professor Bigwood. The symposium was international in character, and was participated in by men from Denmark, the United States, France, Holland, Portugal, Switzerland, and Sweden. The subjects presented were: edema due to protein deficiency; hemeralopia due to vitamin A deficiency; the effects of wartime diets on diabetes; gastrointestinal ulcers; dental caries; dermatoses; tuberculosis; and some more general observations on the health of the human population during the war period. Three papers were devoted to animal nutrition during the war. These were primarily devoted to the problem of protein resources in animal production in Great Britain, Denmark, and

the Netherlands, respectively. The authors of papers were men of distinction, and the volume forms an important contribution to the history of the food problems of humans and animals, as determined by dearth caused by war in parts of Western Europe.

E. V. McCollum

Nutrition of the Dog. *Second Edition.*

By Clive M. McCay. Comstock Publishing Company, Ithaca. $3.50. xiv + 337 pp. 1949.

The author is a distinguished nutrition investigator and has had much personal experience with his subject. It is not too much to say that the breeder, owner, or veterinarian will find in this volume the answers to most of his questions about the nutritive requirements of the dog and how to provide them. There are chapters on Men and Their Dogs, Carbohydrates, Proteins and Fat in the Diet of the Dog, Amino Acids and Protein Derivatives, Mineral Requirements, Fat-Soluble Vitamins, Water-Soluble Vitamins, Modern Dog Feeds, The Ingredients of Dog Feeds, Plant Foods, Testing Dog Feeds, Blood and Bone, Practical Feeding and Management of Dogs, Kennels and Equipment, Parasites and Their Control, Questions about Feeds, A Shelf of Books for the Dog Owner, with an Index of Persons and an Index of Subjects.

The book is well documented with references to scientific papers, placed at the end of each chapter. The total number of references is 374. Every statement is based on experimental data. The reviewer believes this to be the best book in its field.

E. V. McCollum

Feeding Our Dogs.

By Leon F. Whitney. D. Van Nostrand Company, New York, Toronto and London. $3.50. vi + 243 pp. 1949.

This is a book of a very different kind from the one just described. Part I includes an Introduction, Feeding Don'ts, The Evolution of the Dog, and Its Natural Food, the Mechanics of Digestion, and The Chemistry of Digestion. Part II discusses Protoplasm and Protein, Carbohydrates, Fats, Bulk, Water, Minerals, and Vitamins in the Dog's Diet; Calories—the Measurement of Heat in Food; and the question Do Foods Cause Skin Troubles? Part III discusses Foods from Vegetables, Fresh Food from Animals, Packing House By-products, Commercial Dog Foods, and Part IV covers the topics How Much Food Does a Dog Require?; Feeding Methods and Costs; Home Mixing Our Dog Foods; Foods for Special Conditions; and Feeding Problems. There is an Appendix on properties of foodstuffs, and this is followed by the Index.

On pp. 12–13 there is a list of dog diets, designated A to Y, of which it is stated that "Each diet has proved successful in maintaining dogs in excellent condition insofar as food is able to do so." In this list, under C, there is a list of six diet formulas said to have been worked out at universities by years of careful testing. No. 1 in this list consists of a mixture of cane sugar, lard, bone ash, casein, butter, and salt mixture. I believe that no dog could long survive on such a diet. The same may be said of some others in the list. Much of Part I is written in a facetious spirit, and is absurd. The book is not documented, and reads like a compilation prepared by one with little knowledge of physiology or biochemistry from semi-popular articles as sources.

E. V. McCollum

BIOPHYSICS

The Structure of Matter.

By Francis Owen Rice and Edward Teller. John Wiley & Sons, New York; Chapman & Hall, London. $5.00. xiv + 361 pp.; ill. 1949.

In almost every way this is a very unusual book. The authors undertake to explain quantum mechanics without the use of mathematics, and then to apply these explanations to the theory of the chemical bond, solid state forces, spectroscopy, and nuclear chemistry. Far from being too complex to understand for readers without training in advanced physics, it may actually suffer from the disadvantage of being too easy to understand and thus may make the reader feel that he understands points which in reality he does not. This disadvantage, if it is real, is certainly slight beside the very real advantage of making it possible for workers in the biological fields to have at least some understanding of the structure of molecules and the nature of chemical bonds. Of course, a knowledge of the subject obtained in this way will be superficial, inasmuch as it is seldom possible for the authors to prove the statements made and still to adhere to the plan of keeping mathematics out of the book. Such superficiality can be defended if one balances against it the very considerable amount of formal training which would be required of a reader, if the same material were presented rigorously.

L. J. Mullins

Spectroscopic Properties of Uranium Compounds. *National Nuclear Energy Series, Manhattan Project Technical Section. Division III, Volume 2.*

By G. H. Dieke and A. B. F. Duncan. McGraw-Hill Book Company, New York, Toronto and London. $2.75. xviii + 290 pp. 1949.

This book presents a mass of data on the absorption

and fluorescence spectra of a wide variety of uranyl compounds and of a few other uranium compounds. These studies were made on the crystalline solids at different temperatures down to 20° K. The dispersion and resolving power of the instruments used were in general sufficient to resolve the full spectral structure. Included in the presentation is a chapter on the crystallographic structure of rubidium uranyl nitrate, as well as chapters on a variety of techniques and observations incidental to this work. Some of these include observations on the synthesis of particular compounds, effects of isotopic substitution of uranium 235, and the oxygen and nitrogen isotopes and techniques used for growing the large single crystals required in this work. The data for this book were obtained by a group of workers on the Manhattan Project assigned to studies of possible photo-chemical separations of the uranium isotopes. This is an excellent reference work and will be particularly useful to those concerned with solid state investigations.

C. F. HISKEY

NUCLEAR RADIATION PHYSICS.

By R. E. Lapp and H. L. Andrews. Prentice-Hall, New York. $6.00. xvi + 487 pp.; ill. 1948.

This book is written primarily for persons with little background in physics, and as such should prove to be of use as a textbook in nuclear physics courses designed for the non-physicist. By including numerous practical problems, illustrative examples, and an extensive bibliography, the authors have made the book well suited for use as a textbook. Particularly noteworthy are the definitions of the various fundamental units of radioactivity. As a rule, these definitions are supplemented with illustrative examples of a practical nature which should help to make their meaning clear to the student interested in the practical aspects of nuclear physics.

The material in the first five chapters is essentially background material, including a consideration of waves and particles, atomic structure, and x-rays. Of necessity the treatment of these subjects is brief, but the important basic concepts are covered. Chapters six through eight treat natural radioactivity, isotopes, nuclear structure, and nuclear radiations. Aside from a clear presentation of the factual material, these chapters include concise definitions of those quantities primarily useful to the nuclear physicist, (packing fraction, mass defect, binding energy, etc.). Chapters nine, ten, and eleven are devoted to ionization chamber instruments, Geiger-Muller counters, and radiation measurements, respectively. Included with the presentation of the operating principles of the various radiation detectors is a discussion of the limits of usefulness of each instrument. In the next five chapters various aspects of nuclear reactions are discussed; such topics as artificial radioactivity, particle accelerators, the neutron, nuclear fission, and nuclear chain reactions are covered. Chapter seventeen, on radioactive tracer technique, seems to be a little sketchy, considering the importance of the material covered to the biologist, biochemist, and physician. A more detailed discussion of the methods of assay commonly used would be appreciated. The final chapter on Health Physics should be of general interest to those who are working with radioactive materials. Other items of interest contained in the book are tables of useful data on radio isotopes, a list of rules and procedures concerning radioactivity hazards, and a list of manufacturers of radiation instruments.

F. D. CARLSON

HANDBOOK OF RADIOACTIVITY AND TRACER METHODOLOGY. *AF Technical Report 5669. Parts One, Two and Three.*

By William Siri; with contributions by Ellsworth C. Dougherty, Rayburn W. Dunn, James S. Robertson, Cornelius A. Tobias, Patricia R. Weymouth and Maurice C. Fishler. Department of the Air Force, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio. $20.00 for three parts (paper). (1) ii + pp. 1–432; ill.; (2) Pp. 433–582; ill.; (3) Pp. 583–867. 1948.

ISOTOPIC TRACERS AND NUCLEAR RADIATIONS *With Applications to Biology and Medicine.*

By William E. Siri; with contributions by Ellsworth C. Dougherty, Cornelius A. Tobias, James S. Robertson, Rayburn W. Dunn and Patricia P. Weymouth. McGraw-Hill Book Company, New York, Toronto, and London. $12.50. xiv + 653 pp.; ill. 1949.

This book, which appeared first in the limited edition under the aegis of the Army Air Forces early in 1948, and standing first above, has now been revised, enlarged, put into general circulation as the second title listed. It makes available a large mass of data on nuclear radiations collated mainly with the interests of biophysicists in mind. The rather formidable result of this collation, interspersed with what is in general a very adequate description of nuclear processes, is an extended tome which, to quote the jacket announcement, is intended to bridge "the gap between those books intended solely for the nuclear physicist and those which merely describe the results of research in which radioactive isotopes and nuclear radiations were used."

The book is divided into three sections. The first two deal with isotopes, nuclear processes, methods, and instrumentation, and comprise the bulk of the work. The third section, covering only some 38 pages out of a total of 500 in the text, is given over to a discussion of tracer methodology. This rather one-sided organization is the result of the decision to concentrate on the physical rather than biological or chemical as-

pects. However, if one were to take the quotation given above at face value, one would wonder why, if those volumes already available "merely describe" results of research with tracers and nuclear radiations, the authors have been content to refer to these same volumes for more extended treatment of tracer methodology.

The biochemist or physiologist who is interested in the every-day problems of tracer methodology at the working level will not receive much help from this book. However, while most biochemists will not be particularly interested in the great bulk of the data presented, there are many chapters which clinical physiologists and medical biophysicists will find very useful. It seems to the writer, therefore, that the volume would gain immeasurably by deletion of the third section with its associated bibliography and tables. Much of the material on methods and instrumentation has become easily accessible in relatively moderately priced books since this volume was projected. Hence, by deleting or abridging those chapters containing this material, such as chapters 1, 10–15 inclusive, and 19, to cite just a few, this book could be tightened up and brought into a size and price range within reach of all interested. The writer feels that many valuable data have been presented here (and nowhere else) which should be generally available, and that these data should not be included in a matrix of already familiar material which must be purchased along with them.

The book is printed on a glossy stock paper, and legibility is good. The activity of printer's gremlins appears to be low, but a few errors have crept into the text, such as the one in which "atomic number" is stated in the text when "atomic mass" is meant (p. 170).

MARTIN D. KAMEN

BIOLOGICAL REACTIONS CAUSED BY ELECTRIC CURRENTS AND BY X-RAYS. *A Theoretical Study of the Phenomena of Excitation in the Nerve by Different Electric Currents and of the Biological Reactions Caused by X-rays, Both Based Upon a Common Principle.*

By J. Th. Van Der Werff. Elsevier Publishing Company, New York, Amsterdam, London, and Brussels. $5.00. xii + 203 pp.; ill. 1948.

On theoretical grounds there would seem little reason to believe that there is any similarity between the physical processes involved in nervous excitation and those involved in the responses of living systems to x-irradiation. One would rather say that excitation and conduction in nerve reflect the high degree of organization of the cell surface, while radiation effects result from the very random series of chemical species produced in the bulk of the cell. The author of this book has, however, undertaken to develop a mathematical analysis of both these processes on the basis that both effects result from an alteration of the "dynamical equilibrium between assimilation and dissimilation" (i.e., anabolic and catabolic processes). Such a postulated effect is brought about by changes in ion concentrations in both cases. Without considering in detail the data which the author has presented in correlating his theory with the known facts of neurophysiology, one can say that such a theory suffers from many of the difficulties of other mathematical theories, in that it tells the reader essentially nothing about the physical processes involved. Such analyses are inherently no better than purely empirical formulae.

The treatment of the effects of x-rays on living systems is, in some respects, more satisfactory, while in others most unsatisfactory. The introduction of Poisson functions to describe the events occurring seems more justifiable than in the case of excitation. The data used to verify results which are calculated are not those which have been independently obtained (such as mutation rate changes) by several investigators. The explanation of radiation effects appears too simple in view of the known complexity of the purely chemical effects of ionizing radiations. The book is difficult to read because, presumably, of the author's or translator's unfamiliarity with English. It has, further, a strong flavor of vitalism which may disquiet the reader.

L. J. MULLINS

BIOCHEMISTRY

OUTLINES OF PHYSICAL CHEMISTRY.

By Farrington Daniels. John Wiley & Sons, New York; Chapman & Hall, London. $5.00. viii + 713 pp.; ill. 1948.

This is a new edition of the former Getman & Daniels textbook. While the revision is not very extensive, there is little reason for revision at all, as this has for many years been an admirable book. It can be highly recommended to students of biology who need a more basic knowledge of physical chemistry than that which can be obtained from the many books claiming to present "physical chemistry for students of biology and medicine."

L. J. MULLINS

INTRODUCTION TO RADIOCHEMISTRY.

By Gerhart Friedlander and Joseph W. Kennedy. John Wiley & Sons, New York; Chapman & Hall, London. $5.00. xiv + 412 pp.; ill. 1949.

Written as a textbook for chemists, this book has a great deal of material which is essential for biologists working with radioactive isotopes. As the authors have noted in their Preface, the title Radiochemistry needs some explanation. It is not the effects of radiation on chemical substances, but rather the chemistry

and physics of radioactive substances. Those readers familiar with *A Manual of Radioactivity*, by Hevesy and Paneth, will find the subject matter of the two books comparable. The advances of this subject since the last edition (1938) of the latter book, have made an up-to-date treatment of the subject imperative.

A historical introduction to radioactivity is followed by a theoretical discussion of atomic nuclei and their reactions. Later chapters deal with sources of bombarding particles, radioactive decay processes and the statistical considerations involved, techniques for the measurement of radiation, and three chapters on the chemistry of radioactive species. The treatment throughout does not assume previous knowledge of nuclear physics and is satisfying both from a theoretical and a practical standpoint.

L. J. MULLINS

PRINCIPLES OF ORGANIC CHEMISTRY.

By John Leo Abernethy. W. B. Saunders Company, Philadelphia and London. $4.00. viii + 317 pp.; ill. 1949.

This is a concise and lucid introduction to organic chemistry. The author has eliminated much of the material that "tends to make organic textbooks encyclopedic sources of information, discouraging to the beginning student." Of attractive format, the book could fit into an overcoat pocket. In addition to a well organized systematic survey of typical organic compounds, there are brief sketches of theories of electronic structure, bond strain, resonance, orientation influences of substituent groups, and organic oxidations and reductions. Brevity is a great virtue, but here it has been carried a little too far for optimal usefulness in introduction to theory. There are only occasional hints of such amenities as the historical development of the subject or variation in degree of certainty, and no specific citations of source materials or supplementary reading. There are a few errors. Fats are discussed in 9 pages, proteins in 11, and carbohydrates in 20, including optical activity and the proof of the glucose structure. There are student exercises at the end of each chapter, and a good index. The book, in general, reads easily and should be of real value for introductory orientation among the carbon skeletons.

EVELYN HOWARD

THE CHEMISTRY OF HIGH POLYMERS.

By C. E. H. Bawn. Interscience Publishers, New York. $4.50. x + 249 pp.; ill. 1948.

This book fulfills a real need in the field of physical polymer chemistry. It will be extremely useful to polymer chemists interested in the kinetics of polymerization. This does not mean to imply that other topics in physical polymer chemistry, such as The Structure, Stereochemistry and Crystallinity of High Polymers; The Structure and Physical Properties of High Polymers; and The Size and Shape of Macromolecules are neglected, for these topics are also treated in a clear and reasonable fashion.

There has been a tendency for books written in the polymer field to be extremely specific and only to cover limited topics in great detail. This book, without oversimplification, has treated a wide variety of general topics. Thus, it is extremely valuable to the polymer chemist or graduate student in polymer chemistry who desires a fundamental knowledge in the field. Unfortunately, the book has omitted a segment of polymer chemistry concerned with the application of organic reaction mechanisms to polymer problems. Likewise, the application of synthetic organic chemistry to polymer problems has been omitted. Irrespective of these omissions, the book is excellent and a valuable contribution to the polymer literature.

C. G. OVERBERGER

FORTSCHRITTE DER BIOCHEMIE, 1938–1947.

By Felix Haurowitz. S. Karger, Basel and New York. sFr. 40.00. viii + 364 pp. 1948.

The problem of compressing the results of nine years of biochemical research into a volume about one half the size of the *Annual Review of Biochemistry* is certainly formidable, and it is quite difficult to decide how well this has been done. It is relatively easy to point out deficiencies with respect to completeness of coverage for those fields with which one is especially familiar. However, the wide range of the fields covered, and the integration of the various chapters in the book rather makes one wonder whether we shouldn't have such a book in English. The book should be very useful in seminar courses, and as a general reference for non-specialists.

L. J. MULLINS

OUTLINE OF THE AMINO ACIDS AND PROTEINS. *Second Edition.*

Edited by Melville Sahyun. Reinhold Publishing Corporation, New York. $5.00. 286 pp.; ill. 1948.

This introduction to the protagonists in the biological drama, the proteins (and amino acids), was designed as an elementary survey of a field in which several comprehensive works have appeared in recent years. Separate chapters on certain aspects of the chemistry and metabolism of the proteins and amino acids have been contributed by C. L. A. Schmidt, H. B. Bull, H. E. Carter and I. R. Hooper, D. M. Greenberg, M. Heidelberger, A. J. Quick, W. M. Cahill and A. H. Smith, M. Womack and C. F. Kade, and M. Sahyun.

Since the appearance of the first edition in 1944 (see Q.R.B. 20: 297. 1945) the editor has added a timely chapter on the utilization and assay of amino acids by microorganisms. Each chapter has a fairly extensive bibliography.

EVELYN HOWARD

FATTY ACIDS AND THEIR DERIVATIVES.

By A. W. Ralston. John Wiley & Sons, New York; Chapman & Hall, London. $10.00. x + 986 pp.; ill. 1948.

The author is an outstanding contributor to the chemistry and technology of the substances about which he writes. About 100 patents have been granted to him for his discoveries in this field. He is Assistant Director of Research for Armour and Co., of Chicago. His qualifications for authorship in the field of his specialty are thus unsurpassed. The first part of the book is devoted to the fatty acids, their occurrence in nature, their synthesis, and their chemical and physical properties. The second part deals with the synthesis and properties of derivatives of fatty acids, and includes esters, amines, nitriles, alcohols, ethers, mercaptans, sulfides, sulfonates, anhydrides, acid chlorides, aldehydes, ketones, hydrocarbons, soaps, etc. As a reference book this is the best of its kind. There is a 42-page index of topics, but no author index. More than 5000 references to technical literature are included in the bibliographies which follow each of the 12 chapters.

E. V. MCCOLLUM

NATURAL PRODUCTS RELATED TO PHENANTHRENE. *Third Edition of the Monograph Previously Entitled Chemistry of Natural Products Related to Phenanthrene. By Louis F. Fieser and Mary Fieser. Reinhold Publishing Corporation, New York.* $10.00. xii + 704 pp. 1949.

This excellent and comprehensive survey of a major field of organic chemistry first appeared in 1936 as *Chemistry of Natural Products Related to Phenanthrene*, by L. F. Fieser (see Q. R. B. 11: 362. 1936). The authors have aimed to present "reasonably complete topical discussions of a selection of the main points of interest in the chemistry of the phenanthrene derivatives, and to survey more briefly the biochemistry and pharmacology of the compounds. Since the publication of the first and second editions of this book in 1936 and 1937, vast strides have been made in the development of the chemistry of naturally occurring phenanthrene derivatives, particularly the steroids. By 1937 most of the important physiologically active steroid hormones and vitamins had been isolated and their structures established, but very little was known of their stereochemical configurations. Extensive studies of the stereochemistry of the steroids have culminated only in recent years and months in the complete solution of all the major problems concerned. This, therefore, is a particularly appropriate time to present a revision in which we hope we have accurately interpreted a highly confused and voluminous literature in the light of present day stereochemical evidence that seems secure. . . . the present edition represents a complete overhauling of the original book." Some of the earlier chapters and sections have been omitted: e.g., the chemistry of phenanthrene, the carcinogenic hydrocarbons, and the triterpenoid sapogenins. Even so, the book is twice as long as before. Chapter headings are: Quinones; Morphine and Related Alkaloids; Resin Acids; Sterols and Bile Acids; Sex Hormones; Adrenal Cortical Hormones; Steroid Metabolism; Cardiac Active Principles; Steroid Saponins; Steroid and Terpenoid Alkaloids; and a final chapter, by Richard B. Turner, on The Stereochemistry of the Steroids.

EVELYN HOWARD

AN INTRODUCTION TO THE CHEMISTRY OF CARBOHYDRATES.

By John Honeyman. The Clarendon Press, Oxford; Geoffrey Cumberlege, Oxford University Press, London. $4.00. viii + 143 pp. 1948.

As the horizons of research expand ever wider, it becomes increasingly difficult for the individual investigator to remain conversant with all of the advances within his own discipline. These difficulties are multiplied immeasurably as he ventures farther away from his immediate interest. Yet with each advance within his own field he rubs elbows with neighboring branches of science and must frequently incorporate some aspects of these into his work. Thus the biologist must familiarize himself more than ever before with the fields of chemistry and physics.

One solution to his dilemma lies in the publication of textbooks which are concise and basic, yet sufficiently advanced and detailed that they may serve both in an introductory and an advanced capacity. The fulfillment of such a requirement is not so paradoxical as it might appear at first examination. Honeyman's small (143 pages) volume is a prime example.

As the author has stated in his Preface, his aim ". . . has been to provide, in compact form, an up-to-date account of the chemistry of a selected number of carbohydrates. No previous knowledge of the field is assumed, but the reader requires to be familiar with the elements of aliphatic and aromatic chemistry. The monosaccharides are considered in detail in order to provide an adequate basis for studying further the more complex carbohydrates. In addition to the crystalline

di-, tri-, and tetrasaccharides, a few of the simpler polysaccharides of colloidal dimensions are discussed." The configurations and constitution of the sugars are especially clearly presented. The intricacies of ring structure, *d* and *l* forms, and α and β isomers are unraveled expertly.

Biologists whose work carries them into the field of carbohydrate chemistry can hardly do better than to consult this volume. It will serve equally well as a refresher or an introductory textbook.

V. G. DETHIER

NEWER SYNTHETIC ANALGESICS. *Annals of The New York Academy of Sciences. Volume 51, Article 1.*

By M. L. Tainter, H. J. Anslinger, R. C. Batterman, R. N. Bieter, S. Bogolub, K. K. Chen, N. B. Eddy, L. Glassman, B. B. Hershenson, S. A. Hirsh, R. W. Houde, H. Isbell, E. H. Jenney, J. S. LaDue, L. C. Miller, E. E. Nelson, C. C. Pfeiffer, L. H. Rasmussen, E. A. Rovenstine, M. H. Seevers, L. F. Small, R. R. Sonnenschein, and F. F. Yonkman. The New York Academy of Sciences, New York. $2.75 (paper). Pp. 1–174; ill. 1948.

This monograph presents in a well-documented survey the latest information concerning the use of the newer synthetic analgesics, which are: demerol from the piperidine series, methadone from the diphenyl butanone series, and metapon, the newest of the opiate derivatives. The chemistry, pharmacology, analgesic efficiency, drug-addicting properties, and drug complications of each of the three are presented by the outstanding authorities in this field.

As Dr. Batterman concludes that side reactions are much more severe and frequent in the ambulatory than in the hospitalized patient, physicians who use these agents should be prepared to treat promptly the occasional vascular collapse, cerebral edema, bronchial spasm, or respiratory depression in the best environment.

Evidence is presented that many of these agents are better for some individuals than morphine from the standpoint of analgesic efficiency and lack of side effects. Nevertheless, they should be accepted as alternates for morphine and not entirely as substitutes for this most valuable drug. The results concerning many drugs in this series, such as Nisentil, are not yet definite enough to indicate their superiority over demerol. Their use in obstetrics should be carefully regulated, especially for premature deliveries, since in combination with general anesthesia they can, like morphine, perpetrate and accentuate fetal apnea neonatorum. Nevertheless, demerol, at least in obstetrics as in surgery and therapeutics, has already proved itself a reliable analgesic. The other new analgesics in the field of obstetrics are more unpredictable in a potential dangerous depression.

Scientists studying these agents cannot find a better collection of papers on this subject than this.

ROBERT A. HINGSON

MICROBIOLOGY

PRACTICAL BACTERIOLOGY, HEMATOLOGY, AND PARASITOLOGY. *Tenth Edition.*

By E. R. Stitt, Paul W. Clough, Sara E. Branham, and Contributors. The Blakiston Company, Philadelphia and Toronto. $10.00. xiv + 991 pp. + 7 plates; text ill. 1948.

In the eleven years which have elapsed since the ninth edition of this well-known textbook appeared, many advances have been made in the fields which the book embraces. Extensive revisions have consequently been made, amounting to rewriting the sections on Bacteriology and Parasitology. As in earlier editions, the aim of the authors has been to correlate laboratory and clinical evidence. They have included all the available types of laboratory procedures, including newer methods in the various fields. In the section on Hematology, for example, procedures discussed include new work on human blood groups, the Rh factor and its relation to transfusion reactions and erythroblastosis fetalis, preservation of blood for transfusions, and substitutes for blood. The authors have continued to bear in mind the needs of the man in tropical or remote regions, who does not have access to well-equipped libraries or laboratories. This edition, like earlier ones, is completely indexed.

MAX KRAUSS

THE CHEMICAL ACTIVITIES OF BACTERIA.

By Ernest F. Gale. Academic Press, New York; University Tutorial Press, London. $2.25. vi + 199 pp.; ill. 1948.

This little volume is an authoritative condensation of present-day knowledge of bacterial metabolism. Many synthetic and analytic transformations performed by bacteria are briefly reviewed, and their significance in bacterial activities, including pathogenicity, are discussed. Eleven chapters cover such subjects as the nature of bacteria, enzymes, growth, the nitrogen cycle, fermentation, and chemotherapy. The twelfth and final chapter, Some Practical Details, is a sort of appendage to the theoretical considerations, and is inferior to the rest of the book, in the opinion of the reviewer. However, with the exception of the last chapter, the book may be highly recommended. It provides an able, concise, yet elementary presentation of a con-

fusing and difficult subject. It is well suited to introduce the subject to students, or to review it for workers in the fields of bacteriology, cytology, and biochemistry.

HARRIETTE D. VERA

ANTIBIOTICS DERIVED FROM BACILLUS POLYMYXA. *Annals of The New York Academy of Sciences. Volume 51, Article 5.*

By P. H. Long, C. M. Alverson, M. J. Baker, P. H. Bell, R. G. Benedict, E. A. Bliss, J. F. Bone, R. Broschard, G. Brownlee, M. S. Bryer, S. R M. Bushby, B. N. Carle, J. R. Catch, C. A. Chandler, A. C. Dornbush, G. M. Eisenberg, J. P. English, C. E. Fellows, R. C. Gore, K. S. Howard, E. R. Jackson, T. S. G. Jones, G. Krupka, S. Kushner, C. L. Larson, P. Little, E. M. Petersen, J. N. Porter, E. T. Reese, M. M. Rogers, E. B. Schoenbach, R. G. Shepherd, E. I. Short, P. G. Stansly, F. H. Stodola, Y. SubbaRow, A. E. Verder, H. J. White, S. Wilkinson, R. Winterbottom, and J. S. Zellat. The New York Academy of Sciences, New York. $2.25 (paper). Pp. 853–1000; ill. 1949.

AUREOMYCIN—A NEW ANTIBIOTIC. *Annals of The New York Academy of Sciences, Volume 51, Article 2.*

By B. M. Duggar, L. Anigstein, J. Beninson, E. A. Bliss, A. E. Braley, R. L. Brickhouse, M. S. Bryer, C. A. Chandler, M. C. Clark, H. S. Collins, R. Cosgrove, H. R. Cox, R. W. Cunningham, A. C. Dornbush, H. F. Dowling, M. Finland, B. K. Harned, C. H. Hine, L. M. Hill, E. H. Lennette, M. H. Lepper, P. A. Little, M. A. Logan, P. H. Long, W. J. McCauley, G. Meiklejohn, T. F. Paine, Jr., E. J. Pelcak, C. W. Price, A. Prigot, W. A. Randall, M. Sanders, E. B. Schoenbach, E. Stokey, Y. SubbaRow, L. K. Sweet, H. M. Thelen, R. E. Vessey, H. Welch, D. M. Whitney, S. C. Wong, L. T. Wright and N. N. Yuda. The New York Academy of Sciences, New York. $2.50 (paper). Pp. 175–342 + 3 plates; text ill. 1948.

HEALTH AND DISEASE

EVALUATION OF CHEMOTHERAPEUTIC AGENTS. *Symposium Held at the New York Academy of Medicine March 25 and 26, 1948. Number Two.*

Edited by Colin M. MacLeod. Columbia University Press, New York. $4.00. xii + 205 pp.; ill. 1949.

In the Introduction, the editor points out that this Symposium (Symposium Number Two of the Section on Microbiology) dealing with the evaluation of chemotherapeutic agents was "designed to be broad in scope —an attempt to evaluate in a general way certain of the many factors involved in the success or failure of treatment. It has been felt that such a method of presentation is of more value than a division of attention based upon the use of specific compounds in the therapy of particular diseases."

The scope is illustrated fairly by an outline of the topics discussed, which include treatments of the significance of drug concentration in the blood, blood levels and renal clearance in relation to the chemotherapeutic activity of penicillin and certain arsenicals, the significance of protein-binding by various agents, microbial resistance, defense mechanisms of the host, the nature and location of lesions, antibiotic therapy of localized infections, chemoprophylaxis of certain infections, the evaluation of antimalarial drugs, the chemotherapy of rickettsial diseases and of viral infections, and current attempts to define experimental approaches to cancer chemotherapy.

The various subjects are handled in separate chapters by authorities in the several fields. Such authoritative authorship in this instance has served to create a rather unusually interesting and valuable symposium volume. The book may be said to deal with a multitude of facets peculiar to a vigorously growing field. The biochemical basis of chemotherapeutic activity is not stressed here. The work has fulfilled its purpose in providing a number of critical essays on the evaluation of the agents.

LESLIE HELLERMAN

FLIGHT FROM REALITY.

By Norman Taylor. Duell, Sloan and Pearce, New York. $3.50. 237 pp. 1949.

This interesting book deals with various narcotic and so-called habit-forming drugs. The history of usage connected with each one is presented in chronological order and in a highly readable manner, and the many anecdotes are entertaining.

Although the author has at times used the scientific approach, the book itself is not, and was not intended to be, a scientific reference book. All in all, a good piece of work has been done in shedding light on how, where, and why, man found these substances—chiefly from plant life—in order to "break the bonds that chain him to reality."

ROBERT V. SELIGER

ANAESTHETICS AND THE PATIENT. *Sigma Introduction to Science 15.*

By Gordon Ostlere. Sigma Books, London. 7s. 6d. 166 pp.; ill. 1949.

This monograph is directed, according to the author, to an imaginary audience of medical students and collateral scientists, as an introductory compendium presenting the background and present status of anesthesia. The first four chapters, on history, practical anesthesia, how anesthetics work, and the stages of

anesthesia, are basically authoritative and undoubtedly provide useful knowledge for chemists, biologists, any physicists who have contingent liaison with the field of medicine. Likewise, the chapters on the anesthetic drugs, premedication, the development of anesthetic apparatus, are presented in an attractive manner.

The last section of the book, dealing with technic, however, and discussing the applications of anesthetics to the various branches of obstetrics and surgery, does not conform to the opinions of many practicing anesthesiologists today. The decreasing popularity of local and spinal anesthesia throughout Great Britain is contrary to the increasing application of these technics in America. The chapter on anesthesia in midwifery indicates that the author has seen very little satisfactory obstetrical anesthesia. The author's inaccuracy in reporting that caudal analgesia in obstetrics is administered both by the midwife and the mother herself is regrettable. The following sentence illustrates the unwarranted levity in style used through too much of this chapter: "A 'Caesar' actually requires little in the way of anaesthetic to begin with, for, although the abdomen is opened to reach the baby, the mother's abdominal muscles are stretched by her pregnancy to such an extent that they offer little resistance to the hand of the surgeon." During the last four years, as reported to the Congress of Obstetrics in London last year, 77,000 caesarean sections were performed in thirteen major British Hospitals with a maternal mortality of 77. Many of these deaths were related or due to anesthesia. In some sections of England and America maternal mortality from this operation is reported as from one to four per cent, and subsequent infant mortality approaches 12 per cent. There is no operation which requires a more careful assessment of a safe, specifically adapted anesthetic for both mother and baby than caesarean section.

The chapter on curare is basically accurate and is written in an interesting manner. The last three chapters, describing the complications, modern anesthesia, and anesthetics and the patient, conclude a readable elementary description of this phase of the specialty.

ROBERT A. HINGSON

PARAVERTEBRAL BLOCK *in Diagnosis, Prognosis, and Therapy. Minor Sympathetic Surgery.*

By Felix Mandl; translated by Gertrude Kallner. With a foreword by Max Thorek. Grune & Stratton, New York. $6.50. xviii + 330 pp.; ill. 1947.

The author of this book, Felix Mandl, is affiliated with the Hadassah University Hospital in Jerusalem. The first division of his subject consists of three chapters: The Anatomy of Paravertebral Injections; The Technic of Paravertebral Injections; and The Object and Theory of Effect of Paravertebral Block. The second major division has five chapters, dealing with Differential Diagnostic Significance of Paravertebral Block in Abdominal Diseases; Paravertebral Block as a Test Method; The Therapeutic Application of Paravertebral Block; Paravertebral Block in the Treatment of Various Disorders of the Extremities; and Paravertebral Block in the Therapy of Various Diseases and Ill-Defined Conditions. The book has few illustrations or drawings and relies mainly on summaries of cases and case histories for its demonstrations.

The author starts by defining the object of paravertebral injection, namely, to produce anesthesia in the neighborhood of the ganglionated sympathetic cord, the sympathetic ganglia, or rami communicantes of the segments to be eliminated in each case. It is also a very brief review of the anatomy of the vertebral cord and sympathetic system. Mandl next discusses six methods or technics of paravertebral block, all using novocain ($\frac{1}{2}$ or $\frac{1}{4}$ per cent) or novocain-alcohol, with a consideration of their complications and toxic effects.

In Section Two, it is shown that paravertebral block, with proper selection of cases and proper technic, is a valuable aid in the differential diagnosis of cases of abdominal diseases, especially in distinguishing gall bladder pain from renal pain, gastric pain, or pancreatic pain by injection into different thoracic and lumbar segments on the right or left sides. The use of paravertebral blocks as a test method preceding a sympathectomy has been found very useful in predicting the outcome of the operation, although a negative result does not mean the patient would receive no benefit from the operation. In many cases it was found that novocain alone, or novocain-alcohol injection, lessened the need for an operation. The therapeutic application of paravertebral block in relieving the pain of gall bladder or kidney disease was found to be very efficient and often aided or caused the expulsion of calculi. It is efficacious because it abolishes pain rapidly, and also abolishes spasm of the abdominal organs, making a definite change in the tonicity of the organ's musculature by acting through the afferent fibers running through the sympathetic nerves. Considerable space is devoted to discussing the application of paravertebral block to relieve angina pectoris and other "cardiac pain." Paravertebral block is considered the safest and yet the most successful method for the relief of angina pectoris. It has been used successfully to relieve paroxysmal and sinus tachycardia in selected cases. In other cases of pleural pain, pulmonary complications, and asthma, paravertebral block has been used with moderate success. In combination with sacral or transsacral alcohol block for inoperable cases of cancer of pelvic organs it has yielded good relief. It was poor in essential hypertension.

Other conditions in which paravertebral block has proved of much value are: peripheral vascular disorders resulting from injury; arterial spasm; wounds of arteries; arterial hematoma, or false aneurysm;

A-V fistula; traumatic arteritis; traumatic venous thrombosis; after division of peripheral nerves; organic vascular diseases; local effects of cold; and such painful disorders of the extremities as phantom pain after amputation, causalgia, and reflex dystrophy. Sympathectomy was preferred in thromboangiitis obliterans, and very few results were obtained from paravertebral block in cases of Raynoud's disease.

An appendix includes a discussion of the use of paravertebral block in the last war and in rehabilitation surgery. The author believes the complications of vascular and nerve injury will be greatly prevented by his technics and will be of major importance in the future wars.

This is an intelligently written work by a person who has evidently spent many years in studying his subject and is an expert with this technic. He gives evidence of much search of literature on this subject, especially for the period 1916–1933. Although this is commendable, it has tended to make the book confusing in parts because so many theories and refutations are presented. Paravertebral block has been shown to be useful in many cases, but some of these uses can now be replaced with simpler technics, such as continuous caudal, segmental peridural, or spinal blocks.

ROBERT A. HINGSON

PRÉCIS DE BACTÉRIOLOGIE MÉDICALE.

By Pierre Gastinel. Masson et Cie., Paris. 2800 fr. xvi + 1040 pp. + 1 plate; text ill. 1949.

This new textbook of medical bacteriology has been written by a Professor of Bacteriology of the Faculty of Medicine of Paris, to replace the older work of Philibert and Gastinel. The main divisions of the work are comprised of an introduction to general bacteriology and immunology, general bacteriological technique and examination of pathological specimens, and descriptions of individual microbes pathogenic to man, including bacteria, viruses, and protozoa. All organisms likely to be encountered in a laboratory of medical bacteriology are fully characterized, and the immunology, serology, and chemotherapy of infections, as well as other relevant material are recorded.

The classification of Prévot is compared with that of the 1948 edition of Bergey's *Manual of Determinative Bacteriology*. The nomenclature used in the text generally follows that of Prévot, but synonyms are also given. The book is thorough, comprehensive, and detailed, presenting both theoretical and practical aspects of the subject. American workers will undoubtedly find it interesting and useful as a reference. Within the text, however, citations from the original literature are rare; there is almost no bibliography. There are occasional typographical errors. The table of contents follows the index at the end of the book.

HARRIETTE D. VERA

AN INTRODUCTION TO MEDICAL MYCOLOGY. *Third Edition.*

By George M. Lewis and Mary E. Hopper. The Year Book Publishers, Chicago. $8.50. xvi + 1 plate; text ill. 1948.

This third edition continues to serve excellently the stated purpose of the authors "to serve as a primer—it does not pretend to include all the many controversial details and involved technical aspects of the subject." Since the first edition, however, this book has been used to advantage by beginners and advanced students alike. The first-hand experience of the authors with the materials presented and their ability to present concisely this material has allowed the book to become a standard textbook in medical mycology.

The original plan of the book has been maintained with two sections. The first deals with the clinical, theoretical, and experimental aspects of fungus infections; and the second, with laboratory methods. Advances in medical mycology since the second edition (1943) have been added without materially increasing the length of the book. The original illustrations are without fault, and the additional figures also are excellent.

NORMAN F. CONANT

VIRUS DISEASES OF MAN. *Second Edition.*

By C. E. van Rooyen and A. J. Rhodes. Thomas Nelson & Sons, New York. $22.50. xiv + 1202 pp.; ill. 1948.

This second edition is a substantially improved and extended, but basically unaltered, revision of a book that fulfills excellently the purpose stated in its preface: "to provide a volume of reference for both the laboratory worker and clinician interested in the field of human and animal virus infections." In the opinion of the reviewer, this book remains the best treatment of the subject available in English. It is indeed remarkable that two workers have mastered and organized so critically such a wealth of factual information and bibliographic material.

The form of presentation is a succession of statements of published observations, which reminds the reader of another excellent book, Topley and Wilson's classic *Principles of Bacteriology and Immunology*. This makes the book more useful for reference purposes than if the subject matter had been treated in a more discursive way. The first section, on methodology, is adequate but disproportionately short and scanty in the treatment of the theoretical considerations underlying the methods described. The main part, sections 2 to 12, contains a detailed discussion of all virus diseases of man whose etiology is well established. Rickettsial diseases are not discussed, although the psittacosis-lymphogranuloma venereum group of diseases, a borderline group, is included.

Altogether, this volume, following the classical approach of medical virology, appears to be the best that the pathologist can do in attempting to do justice to this field. It will be very useful also to those workers who are now attempting to approach the virus problem as a primarily biological problem.

S. E. Luria

Atlas of Cardiovascular Diseases. *Correlation of Clinical Electrocardiography and Cardiac Roentgenology with Clinical History and Autopsy Findings.*

By Irving J. Treiger. The C. V. Mosby Company, St. Louis. $10.00. 180 pp.; ill. 1947.

Treiger has correlated the classical uncomplicated clinical history and physical signs, roentgenologic findings, electrocardiographic changes, and gross pathology in the more important varieties of cardiovascular conditions. The book begins with a sound presentation of the normal heart and then takes up rheumatic heart disease, arteriosclerotic heart disease, hypertensive heart disease, syphilitic heart disease, and congenital anomalies of the heart and large blood vessels in an orderly, museum-like fashion. The generally satisfactory roentgenograms, electrocardiographic tracings, and photographs (some in color) are accompanied by a minimum of text, so that individual cases may be studied quickly.

Unfortunately the electrocardiograms include only the four old standard leads. There is but passing mention of multiple precordial leads and no consideration of the valuable unipolar limb leads. In addition, selection and quality of a number of the pathological specimens could easily be improved.

Despite these criticisms, the atlas is well integrated and can be thoroughly recommended as a brief review and reference book in this important field.

E. Converse Peirce, 2nd

The Peripheral Circulation in Health and Disease. *A Study in Clinical Science.*

By Robert L. Richards; With a Foreword by J. R. Learmonth. E. & S. Livingstone, Edinburgh. $6.00. xii + 153 pp.; ill. 1946.

As a result of the segregation of similar cases by the British Medical Research Council, Dr. Richards has had an unparalleled opportunity to study large groups of peripheral vascular diseases which are ordinarily infrequently observed. His small book is a beautifully written and scholarly account of his studies of these diseases, primarily by means of skin temperature measurements. Fully aware of the limitations of his method, the author has reviewed the related literature very thoroughly and has skilfully integrated it with his own observations.

The book includes a concise and critical account of the anatomy and physiology of the peripheral vasomotor system, a clear discussion of methods of study with particular reference to skin temperature measurements, an exposition of spontaneous and imposed vasomotor activity, and the results of studies in four major groups of peripheral vascular disorders: occlusive vascular disease, the Raynaud phenomenon, peripheral nerve injuries, and the immersion foot syndrome. There is much material not readily available in other works on the subject. Each chapter is fully annotated. Those who are seriously interested in studies of peripheral circulation will find this book a considerable addition to their libraries.

E. Converse Peirce, 2nd

Your Skin and Its Care.

By Howard T. Behrman and Oscar L. Levin. Emerson Books, New York. $2.50. 255 pp.; ill. 1948.

The authors, who are skin specialists, present a program of skin hygiene which will help to "beautify the skin, to avoid skin disorders, or—should they already exist—to correct them." Underlying causes of skin diseases are discussed at length, symptoms are described, and treatments indicated. The relations between skin and general systemic conditions are set forth, and the authors touch upon recent psychosomatic developments in dermatology. The uses of cosmetics in skin care and their dangers receive appropriate attention. This book is a popular household reference manual on the proper care of the skin, so often neglected. It is practical, and will be easily understood by the average reader. A glossary, index, and eleven illustrations are included.

Joseph C. Franklin

Medical Aspects of Growing Old.

By A. T. Todd. A William Wood Book. The Williams & Wilkins Company, Baltimore. $3.50. viii + 164 pp.; ill. 1946.

This little book is principally a handbook on rules for healthful living. Clearly and simply written, it should be of definite value to any layman who wants to enjoy a vigorous old age. The first three chapters are devoted to a consideration of the real and supposed changes associated with ageing. Here Todd states his thesis that the wearing out of the body is "not . . . by the attrition of so much work, but rather, as in the case of badly kept machinery, from neglect and ignorance." The remaining 16 chapters provide detailed instructions on how to care for the machinery of the body. The problems of diet and digestion are dealt with at length, as might be expected. Cardiovascular troubles, genito-urinary disorders, and care of the

nose, skin, hair, and feet are taken up, and there are also chapters on sleep, exercise, and the requisites of a satisfactory retirement. Throughout, the author is completely specific, and his advice is often refreshing for its simplicity and directness. The sufferer from insomnia, for example, is advised to get up and try staying awake.

No one who writes on health is entirely free from personal prejudices, and Todd is no exception. Milk he regards as virtually a toxic substance in the adult diet; and grey hair he classifies among the "results of incorrect living." But these are minor flaws in a book distinguished for its good sense. Above all the author stresses the simple and natural means of fostering and preserving health. The book may be especially recommended to those who have exposed themselves too much to the misinformation purveyed in advertisements and newspaper columns. There are two appendices dealing with the caloric and vitamin content of common foods, and also a surprisingly good index.

FLORENCE MOOG

MODERN TRENDS IN PUBLIC HEALTH.

Edited by Arthur Massey. Paul B. Hoeber, Medical Book Department of Harper & Brothers, New York. $12.50. xii + 581 pp.; ill. 1949.

This monumental work of 23 monographs by a like number of British experts covers most of the broad field of public health, and is presented as a summary of the development of British health services and activities during the recent war and the early phases of social readjustment which have followed. Such topics as Nutrition and Public Health, Public Health Nursing, School Health Service, Occupational Health, and Health Education are discussed in relation to the total British public health situation by leading authorities in the several disciplines. In many instances, the historical development of the particular phase of public health under consideration has been presented, as well as some indication of those trends most likely in the future. Since the monographs are complete within themselves (each with summary and bibliography), they have been arranged by alphabetic order of the author's name.

The monographs reveal patterns of social development in public health which will undoubtedly be studied and discussed with equal interest by those either advocating or opposing any major change in the status of public health and medicine in the United States. Although the work has been prepared by British Public Health experts, drawing upon their British experience, there is sufficient material here of general interest and application to the entire field, that it can be profitably used for classroom or reference work in public health training and activities in any part of the English-speaking world. A complete index is appended.

B. AUBREY SCHNEIDER

PUBLIC HEALTH IN THE WORLD TODAY.

Edited by James Stevens Simmons; assistant editor, Irene M. Kinsey; with a foreword by James Bryant Conant. Harvard University Press, Cambridge; Geoffrey Cumberlege, Oxford University Press, London. $5.00. xviii + 332 pp. + 5 plates; text ill. 1949.

This is a collection of twenty-four papers which were presented at a series of Public Health Forums held at Harvard University in 1947–48. The four sections of the book are: The Profession of Public Health; Public Health in the United States Today; Public Health Programs and Problems Abroad; and Public Health in a New Era. The development and present-day concepts of public health are set forth in a vigorous and forceful manner. The status of federal health and medical care services, nutrition, occupational hygiene, and child health is surveyed. Problems of transportation, especially aviation, and of international organization for the promotion of public health services are discussed. The advent of the atomic era, with its new implications for public health, is not forgotten. The result is a timely and significant publication. It should be read carefully and thoroughly by those who are concerned with, or profess any interest in education, public health, medicine, or world affairs. It is thought-provoking and enlightening.

HARRIETTE D. VERA

PSYCHOLOGY AND ANIMAL BEHAVIOR

HISTORICAL INTRODUCTION TO MODERN PSYCHOLOGY. *Revised Edition.*

By Gardner Murphy. Harcourt, Brace and Company, New York. $4.50. xiv + 466 pp.; ill. 1949.

This is the second edition of Murphy's popular textbook. The first half of the book, made up of two parts on the early history of psychology, has been changed only a little; the second half has been extensively revised. The latter contains two parts: one, consisting of six chapters, under the heading of Contemporary Psychological Systems; the other, also with six chapters, on Some Representative Research Areas.

Murphy's history is more eclectic than Boring's *History of Experimental Psychology*—the only other good textbook in the field. In his attempt at comprehensiveness, however, Murphy has had to sacrifice the kind of detail that characterizes Boring's book. As one might expect, the sections on psychological systems and contemporary research areas, particularly the latter, reflect the author's own perspectives. Although it would be virtually impossible, of course, to escape some bias, it is unfortunate that the author did not present a more balanced synopsis of current trends in research. Despite its shortcomings, this book, like its predecessors, is a useful addition to the psychologist's library.

A. CHAPANIS

DYNAMIC PSYCHOLOGY. *The Century Psychology Series.*

By Percival M. Symonds. Appleton-Century-Crofts, New York. $3.75. x + 413 pp. 1949.

This textbook of psychology constitutes an abridgment of a previous book, *The Dynamics of Human Adjustment.* The book leans heavily on psychoanalytic interpretations while claiming to eliminate those quotations less acceptable to the consciousness of most persons and hence which seem least convincing. It also eliminates the dynamics of abnormal states and its unfamiliar vocabulary. There are chapters on the ordinary varieties of human tendencies and of mental mechanisms, and a final chapter on normality. There occurs twice (p. 2) an unfortunate misuse of a term, a misuse not excusable in a textbook: "It conceives of man as an organism which is responsive to the world about and who is capable of *affecting* efficient adaptation to the environment through the operation of his mental processes." "Although they function on more simple and rudimentary levels than man, they also *affect* a working relationship with their environment." [Italics added.]

WENDELL MUNCIE

THE CHILD IS RIGHT. *A Challenge to Parents and Other Adults.*

By James Hemming and Josephine Balls. Longmans, Green and Company, London, New York, and Toronto. 6s. xiv + 176 pp. + 7 plates. 1947.

This is a determinedly cheerful little book gaily addressed to parents. The authors are reported to "have worked for many years among children of all ages," but the exact nature of this work is not explained. Whatever it was, it made possible a phenomenal accumulation of anecdotes to illustrate homey truths about how to understand children. These "truths" are good natured, common-sense ideas which can hardly be over-stressed, but their presentation here seems to fall flat. This may be due to the British authors' use of English idioms which strike an American reader as forced or inappropriate, or it may be that neither author has a real gift for the humorous style which can by some magic take a serious topic and make it palatable and effective at the same time.

HELEN ARTHUR

GROW UP—AND LIVE. *Pelican Books 149.*

By Eustace Chesser. Penguin Books, Harmondsworth, Middlesex. 1s. 6d. (paper). 295 pp. 1949.

Chesser has written an informal, chatty book directed toward the adolescent reader. He covers a tremendous area—beginning with descriptions of the various body systems, going through a section of early childhood problems, and concluding with several chapters on attaining maturity. At first glance it might seem that he has taken in too much, but when it is recalled that to the adolescent the world is just such a panorama of past, present, and future questions, it seems to be a peculiarly appropriate approach for the audience he has in mind. Throughout, he steers a middle course between the over-elaborate explanation and the useless generality or discreet euphemism. Altogether, this seems like quite a good book to give an intelligent teenager whose family has not been able to talk freely with him.

HELEN ARTHUR

HOW PERSONALITIES GROW.

By Helen Shacter. McKnight and McKnight, Bloomington, Illinois. $3.00. 256 pp.; ill. 1949.

Helen Shacter has written a very readable little book. She quietly and interestingly introduces the reader to the concept of personality, and then effortlessly leads into some of the complicated facets of personality development, the different social needs that influence a person's reactions, and at length some of the various defense mechanisms that operate along with efforts to satisfy these social needs. The last two chapters are concerned with suggestions for improving one's personality in the light of increasing self-knowledge.

How Personalities Grow is remarkable for its clear, cool style. It can be read rapidly. Frequent pleasant pictures make the going even easier. Behind this surface, however, is a core of genuine feeling and information conveyed to the reader without tension or passion. This volume would seem especially suitable for women —from highschool or college girls on in years—who are often deeply concerned with their personalities and what to do about them.

HELEN ARTHUR

PSYCHOLOGY OF PERSONAL ADJUSTMENT. *Students' Introduction to Mental Hygiene. Second Edition.*

By Fred McKinney. John Wiley & Sons, New York; Chapman & Hall, London. $6.00. xii + 752 pp. + 12 plates; text ill. 1949.

This is a beginning textbook in psychology, but it is certainly appropriate reading for any person, particularly any college student, who is interested in the problems of adjustment. It is specifically directed toward the adjustment of the college student, beginning with the most concrete sorts of problems, such as efficient study methods, and the development of personal efficiency in college. From this specific and concrete beginning, the most general and abstract problems of conflict and frustration are gradually introduced. The final sections of the book deal with general social adjustment and the implications of psychology for a healthier society. The book is very readable throughout, profusely illustrated with case material and some

very effective photographic illustrations. This edition, in contrast to the first, presents more conceptualization of the problems of personality, but it is not a coherent presentation of a scientific theory of personality. Some readers may object to the book on these grounds, but if so they quarrel with the author's objectives. For what he intended, the book is extremely well done.

ALFRED L. BALDWIN

ESSENTIALS OF PSYCHOLOGICAL TESTING.

By Lee J. Cronbach. Harper & Brothers, New York. $4.50. xiv + 475 pp.; ill. 1949.

The field of psychological testing has become, according to Cronbach, so complicated that a survey of psychological tests is no longer a feasible undertaking. Instead, the emphasis should be upon the intelligent choice of tests. In this volume the author has attempted to provide the student with criteria for making intelligent choices of tests which will suit the particular needs of the situation.

The book seems well designed to achieve the author's purpose. Among other discussions there is an excellent one on reliability and validity, a good section describing the importance of the subject's perception of the test situation, and very competent concise reviews of material on a number of specific tests. In discussing tests of ability the contributions of factor analysis are well described. The final section describes various kinds of measurements of personality characteristics, including behavioral observations. The discussion of projective tests seems somewhat weaker than the rest of the volume.

ALFRED L. BALDWIN

INTRODUCTION TO THE SZONDI TEST. *Theory and Practice.*

By Susan Deri; with a foreword by Lipot Szondi. Grune & Stratton, New York. $5.00. xiv + 354 pp.; ill. 1949.

This is the first discussion in English of a projective personality test devised by Dr. Lipot Szondi, a Hungarian psychiatrist. In the test itself the subject chooses from each of six series of photographic portraits those he likes most and dislikes most. These pictures include homosexuals, sadistic murderers, epileptics, hysterics, catatonics, paranoids, manics, and depressives. By charting the subject's preferences for these various photographs, on a number of occasions, a series of test profiles is obtained. This information permits, according to the proponents of the test, a detailed personality description and diagnosis.

In this book the rationale for this interpretation is presented. Corresponding to the eight types of people in the series of photographs are personality characteristics, which are given a full discussion. The book contains very little empirical evidence which would permit the reader to make an independent judgment about the validity of the test interpretations, but it does present the rationale in such clear, logical fashion that the reader comes away from the book with an open-minded attitude about the possibilities of such a test. Even if the test is invalid, it introduces some extremely interesting psychological concepts that may well be important contributions to psychological thinking.

ALFRED L. BALDWIN

SOME NOTES ON THE PSYCHOLOGY OF PIERRE JANET.

By Elton Mayo. Harvard University Press, Cambridge. $2.50. x + 132 pp. 1948.

Shortly before Mayo and Janet were to commence collaborative work applying the latter's particular psychological views to the study of social and industrial problems, Janet died. This small volume (dedicated to Janet) summarizes the French psychologist's conceptual scheme for clinical study, his equilibrium hypothesis of behavior, and his brilliant delineation of hysteric and obsessional states. On these subjects the exposition is clear and concise. The author's attitude that Janet's theories and work should be appreciated for their contemporary usefulness, rather than for their historical importance in medical and psychological science will be shared by few professional readers. Moreover, the author's unqualified agreement with Janet's general biological bias in the etiology of mental illness and, in particular, with his view that hysteria is a consequence of organic and constitutional degeneracy, is hardly tenable today.

Although the author is concerned to bring the value of Janet's work to the thinking of those dealing broadly with "the difficult social, personal, and administrative problems of our time," he has failed to develop Janet's contribution beyond the level of individual and clinical psychology to its application in interpersonal relationships, except for such generalizations as this:

> The three simple claims of the Janet psychology that I have here outlined are of extraordinary importance to all students of society. The first two—the complexity of the attentive act and the interrelation of action and reflection—he should study under the guidance of a competent psychologist in preparation for his work. This he must do in order that he shall be able instantly to detect the third group of symptoms—constraint and the emergence of obsessive thinking—when such symptoms appear in any social or industrial situation he is studying. For the appearance of such symptoms will warn him that there is some irksome constraint or feeling of insecurity imposed upon the individual or the group studied by the general conditions of the surrounding.

However true such statements may prove to be they fall short, in the reviewer's opinion, of being revelatory or immediately helpful to those to whom the author has directed his book.

As an addendum to his notes on Janet's work, Mayo has included Janet's lecture on Frightened People, a lecture dealing with the need of medical patients for reassurance and urging attending physicians to recognize the importance of psycho-social counseling as a necessary aspect of physical treatment.

JOSEPH C. FRANKLIN

VARIETIES OF DELINQUENT YOUTH: *An Introduction to Constitutional Psychiatry.*

By William H. Sheldon with the collaboration of Emil M. Hartl and Eugene McDermott. Harper & Brothers, New York. $8.00. xviii + 899 pp.; ill. 1949.

Sheldonism has become something to be reckoned with in these days when panaceas and utopias are sought for in the magic of numbers. Around the Director of the Constitution Laboratory at the College of Physicians and Surgeons of Columbia University there has collected a cult as mandarin-like and as cabalistic as any of those (especially the psychoanalytic) against which he rages wrathfully in a style that reads like the miscegenous mating of Bernard Shaw with Philip Wylie. Latterly he has been taken to the bosom by certain literary luminaries (*habitat Californiensis*): among science-fictioneers he is the acknowledged darling; and for the outraged sensibilities of the anti-Freudians he is the leading manufacturer of precious balm. As he goes forth in print every few years to do battle against the forces of stupidity and evil, he wears the token of the eugenicists on his helmet, whence it flutters in the wind of his going like the squirrel tail from the motorcycle of the young psychopath who just tore past my study window.

In this, the third volume of the Human Constitution Series—and the weightiest by bulk—Sheldon has used delinquency as the vehicle for his diatribes. Two hundred youths, sometime residents of the Hayden Goodwill Inn, a Boston rehabilitation home for boys, provide the raw data for this study. Sheldon presents them in a wearying procession, single file, replete with the by-now-famous Somatotype Performance Test, i.e., triple-view photograph, standard somatotype description embellished with characteristic adjectives and highly subjective paragraphs relating to Temperament, Delinquency, Origins and Family, Mental History, Medical Running Record, Summary, and Comment. Introducing in this volume, for the first time, a scale for the measurement and description of the psychiatric variables as well as a new Index of Delinquency (or Disappointingness), Sheldon now attempts to round out the so-called "biologically oriented psychology" which he hopes will rescue the study of man from the fiendish grasp of the Freudians and set it upon the highroad toward a biological humanics.

The work presented here is open to the same criticisms that have been made against previous work published by Sheldon and his colleagues. Both methodology and statistical treatment betray the author's own Dionysian temper, and he seems not to have taken too seriously the objections raised in scientific quarters against his high-handed way of treating experimental data in the past. While, in this volume, he has gone to commendable lengths to validate his scale for the quantification of psychiatric variables, the ID (Index of Delinquency) appears contrived. Finally, the entire study reveals again the typical Sheldonian scientific sins of limitations of sampling and possible contamination through methodological subjectivity and bias.

In all this welter of data, amidst all the charts, tables, figures, schemes, and photographs with which this giant of a book is filled, the conclusions of the research are quite lost. Perhaps, though, it were better to say they are hidden and obscured by the semantic fog these constitution researchers have raised in their attempt to explain and quantify their work. Diligent search, however, discloses that the "criminals" studied are "pronouncedly ectopenic mesomorphs with about average endomorphy," are of moderately short stature, are psychiatrically Dionysian "with a mild sustaining paranoia," are of average primary *g* (gynandrophrenia) but of a low secondary *g*, and of "almost average primary *t* (aesthetic pleasingness) but of lower secondary *t*," excel in general strength and athletic ability but are of "only average hand strength," and possess a mean IQ "at about the level sometimes called normal subaverage." We learn, too, that their maternal parentage is recognizably "burgeoned," and that they and their sons are, as a whole, cerebropenic; also, that the parents of delinquents are quite as delinquent as the delinquents studied, themselves. The relationship between the burgeoned state and cancer and that between hebephrenia and asthenia give Sheldon an opportunity for some interesting speculations as to biological delinquency, and he takes advantage of it with enthusiasm.

Reading Sheldon, I am always tempted to ask, What's all the shouting about? After all, it was Freud who said, "Anatomy is Destiny"—thus paraphrasing Napoleon—and no psychologist worthy of his degree would question that the morphology and physiology of the body are dynamically interrelated with the functioning organism. I cannot but suspect the company Sheldon keeps and the sources of his information. His special peeve is the psychoanalyst, and upon him he pours a verbal venom that should make even Monsignor Sheen jealous. As a psychoanalyst myself I must object strongly to the sneering implications of Sheldon's characterizations of myself and my colleagues. We do, indeed, have our lunatic fringe; but I rather believe it consists of people who have misread and mis-

interpreted Freud and his followers exactly and to the same extent as Sheldon has. No psychoanalyst of my acquaintance, at least, would deny the worth of morphological research nor fail to recognize and respect its adjuvant function in the study of man and his behavior. But—if I may speak for the bulk of my colleagues—we do not think that Sheldon's methods or results yet entitle him to speak with the voice of authority and prophecy.

All of this is not to say that Sheldon should not be read. He should; for there is a hard core of scientific truth beneath the exuberant posturings, and the hypotheses upon which the research is founded are certain eventually to assume an important place in the ongoing search for more knowledge about ourselves. Moreover, Sheldon should also be read for the sheer fun of it. In this book, especially Chapter Six is guaranteed to entertain. Here Sheldon, taking his cue from the materials of his research, really lets himself go on his most cherished prejudices—Freudianism, Mr. 7-7-7 (better known as Mr. G or just plain JC), and Roosevelt. While to some of us it may seem strange to find the distinguished proponent of a biological humanics harboring the biases of ordinary mortals and concerned like the veriest college sophomore with what is best described as the apparently permanent effects of a religious hangover, none of us can afford to miss the opportunity to sit at the feet of a modern Jeremiah clothed in cap and gown.

(By the way, Dr. Sheldon, this reviewer is a psychoanalyst: somatotype about 3-3½-4. Primary g ±, secondary g + 1. Primary t 4, secondary t 2. Temperament cerebrotonic, ψ probably 5-2-3.)

ROBERT LINDNER

THE YEARBOOK OF PSYCHOANALYSIS. *Volume 4. 1948. Edited by Sandor Lorand. International Universities Press, New York.* $7.50. 356 pp. 1949.

In the fourth volume of the *Yearbook of Psychoanalysis* the editors have again collected a series of absorbing and provocative papers in the psychoanalytic field. There are twenty-two papers altogether. The first is devoted to an obituary of A. A. Brill, one of the leaders in the psychoanalytic movement in this country, who died in 1948. The next three papers have historical interest in relation to the psychoanalytic movement—one being an actual report from the minutes of the Vienna Psychoanalytic Society, and two concerned with Josef Popper-Lynkeus, a thinker and poet of Vienna who had considerable influence on Freud.

The majority of the papers, contributed by such well-known psychoanalysts as Ernest Jones, Kate Friedlander, and Bernhard Berliner, have to do with specific contributions to psychoanalytic theory. They are all written for the edification and stimulation of those who are already well grounded in basic psychoanalytic concepts, and are extremely challenging. They represent the best of the psychoanalytic writing through the year.

Eight papers in the book are devoted to current psychoanalytic research projects. Five of these have to do with the psychoanalysis of literary material. These are interesting. One, by Felix Deutsch, is an examination of The Respiratory Neurosis of Charles Kingsley. It is a fascinating and learned, detailed examination of *The Water Babies* and *Anton Locke's Dream*, from which the author proves how Kingsley's psychosomatic illnesses directed his literary endeavors. Skinner does a similar kind of psychoanalytic exploration of Lewis Carroll's *Adventures in Wonderland*. It is an interesting case report on the author as seen through his work and some biographical data. In a sense these scientific dissections of well-loved masterpieces detract considerably from one's enjoyment of these classics themselves, but they do contribute rather dramatically illustrated clinical material for a psychoanalytic presentation.

There is no doubt that this *Yearbook*, now in its fourth volume, is an important addition to every psychoanalyst's library. It presents a carefully culled and representative group of the most important papers of the year.

HELEN ARTHUR

ENCYCLOPEDIA OF CRIMINOLOGY. *Edited by Vernon C. Branham and Samuel B. Kutash. Philosophical Library, New York.* $12.00. xl + 527 pp. 1949.

Under the very best of circumstances, no encyclopedia can be reviewed adequately. The very nature of such a multipedal beast precludes its being treated according to the critical standards usually applied toward other publications. It coheres only because it is thinly united by a topical thread and a meticulous conformance to the punctate demands made upon it by the alphabet. Finally, it labors mightily for completion, catholicity, and authority, but is foredoomed at best to produce only a struggle and a confusion between its covers as it comes closer and closer to realizing such intentions.

The best that can be said about the particular encyclopedia under discussion is that, where the form of publication does not defeat them, Branham and Kutash have performed creditably an onerous task. Criminology is a bastard discipline, a chronic borrower from every possible science and field of study. Perhaps more ambitious editors would have ranged more widely in their search for material and so have demonstrated this further than Branham and Kutash have done; but then the bulk of the product might have frightened away prospective readers. As it stands, there is enough here to demonstrate the tremendous scope and

direction of what has always been a fascinating, if little rewarding, adventure of the inquisitive intellect. The subject itself emerges—as it indeed is—an embryonic discipline painfully groping toward a minimum requirement of objectivity on its long way toward sciencehood. Beneath its perhaps too spacious semantic blanket, it has had to pair off and seek to unite strange bedfellows. The outsider who, all unwary, plunges into the midst of its present chaos must, alas, be most impressed by the monstrous couplings he observes, and the queer offspring that to his unaccustomed eye appear to defy Mendelian predictability. All of this, from *Abandonment* to *Usury* and beyond, is well illustrated in the pages of this volume.

As a citizen cognizant of his responsibility to remain informed, the biologist will naturally be interested in this work on a subject so important to the national welfare. As a scientist, he will deplore certain individual pieces for their subjective and undeservedly conclusive tone. As a general reader, he will regret the poor quality of the binding, the unsuitable paper-stock, the completely useless index, and the outrageous price he is asked to pay for a book of only a little more than five hundred pages.

ROBERT LINDNER

HUMAN BIOLOGY

GROWING SUPERIOR CHILDREN. *Revised Edition.* *By I. Newton Kugelmass. D. Appleton-Century Company, New York and London.* $5.00. xvi + 590 pp. + 8 plates; text ill. 1946.

GROWTH AND DEVELOPMENT OF THE YOUNG CHILD. *Fourth Edition.* *By Winifred Rand, Mary E. Sweeny, and E. Lee Vincent. W. B. Saunders Company, Philadelphia and London.* $3.00. viii + 481 pp.; ill. 1947.

As indicated by the titles, the approaches of these two volumes differ somewhat. Kugelmass is more concerned with telling people, particularly parents, how to deal with children in order most effectively to promote physical, mental, and emotional growth. Rand, Sweeny, and Vincent are more inclined to describe the growth process and to account for differences. Kugelmass is more inclined to lay down the law, to say "this is so" and to give, for example, very specific and detailed instructions for punishment, sex education, work, play, sleep, exercise, etc. Rand, Sweeny, and Vincent prefer to give evidence of research in these areas. Unquestionably more scholarly in their approach, the latter authors cite 417 references in their bibliography. Kugelmass has no bibliography at all, restricting himself to a glossary. Laymen, however, will probably prefer the treatment by Kugelmass. In the reviewer's experience, most parents are inclined to ask for specific instructions about their children, rather than scientific explanations of behavior and development, or results of research.

The areas covered by the two books are quite similar. Rand, Sweeny, and Vincent begin with current concepts of growth and development. They point out that rapidity is not necessarily desirable, that children may be different yet normal, and that readiness (maturity) is prerequisite to learning. The discussion of home and family as the background of growth is well handled and covers the whole gamut of psychological and sociological forces from birth control to juvenile delinquency. Characteristic of the authors' approach is their statement regarding compensation: "The human body has a tremendous power of compensation in the physical realm. It learns to adjust itself sometimes to almost unbelievably difficult handicaps, and it would seem as if this principle were true in regard to other aspects of life as well. One would not deliberately set up economic, physical or social handicaps for any child, but if they do occur one must not consider them necessarily overwhelming, dooming the child to what the condition seems to indicate. There may be inherent in the very challenge of difficult situations compensations worthy of consideration and the liabilities may indeed become assets."

The ensuing discussions deal with preconceptional preparations, including such matters as preparation of the siblings; physical equipment (in great detail) for growth and development; care and feeding of the growing child, including frequent citations from research and descriptions of individual cases; intellectual growth; and social and emotional growth. The 63 illustrations are very good in general. The intent of the authors that the book be used as a textbook is revealed by the itemization of topics for class discussion, as well as references at the end of each chapter. *Growth and Development of the Young Child* is a fourth edition, and the major alterations are in the fields in which most new knowledge has been attained in recent years: those dealing with intellectual, social, and emotional growth.

Growing Superior Children is also a revised edition, and in this instance the greatest amount of change is reported to be in the area of nutrition. The title of the opening chapter is Perfecting the Newborn Prenatally. The next chapter deals with Evaluating the Newly Born Baby. Throughout the book, the emphasis is on "promoting, perfecting, cultivating and adjusting." A quotation from Chapter 20, Personality in the Making, may be revealing. "Instinct is the most deep-seated mechanism of the central nervous system. It operates through the bodily organs as equipped by Nature, whereas intelligence devises new tools for self-preservation. Instincts, however, are molded into the very flow of life, which intellect can neither comprehend nor modify. Whatever the developmental status of the individual, the instinctive drives persist unto his end. The major instincts are self-preservation, sex, and

sociality, and upon the adjustment of these, much of the personality depends." There are nine plates and 29 drawings and diagrams, most of which are very good. Probably more illustrations would have been helpful in both books. The dust jacket on Kugelmass' book is most attractive.

The reviewer may seem to have favored unduly the book by Rand, Sweeny, and Vincent. In all fairness, the difference in purpose of the two books should be kept in mind. There is undoubtedly a place for such books as *Growing Superior Children*. If taken cum grano salis and followed by a healthy dose of something like *Growth and Development of the Young Child*, it might serve a very useful purpose.

ARTHUR LICHTENSTEIN

TEMPERATURE AND HUMAN LIFE.

By C.-E. A. Winslow and L. P. Herrington. Princeton University Press, Princeton. $3.50. xiv + 272 pp. + 5 plates; text ill. 1949.

Most investigators concerned with problems of heat exchange between the human body and its environment are familiar with the series of papers on the subject which issued from the John B. Pierce Laboratory of Hygiene over the years 1935–1940. These described methods of partitional calorimetry and derived principles from their use which enabled a satisfactory mathematical expression to be given to such problems of heat exchange. They undoubtedly deserve a place in history as critical developments in the field of thermal physiology. Most workers with whom the reviewer has talked, however, share with him, at least in private conversation, a certain impatience with the complexity of the presentation adopted in these papers. The first three chapters of this volume summarize much of this material, and do so in a way which is much simpler than that used in the original papers. The claims of the publisher that "the discussion may be followed by anyone with a background of elementary science" are quite true; but readers will need a fairly firm determination, for the style is still more pedagogic than stimulating. It is the hope of the reviewer that such determination will indeed be shown by an important number of "architects, heating and ventilating engineers, designers of clothing, public health officials, doctors," etc., since the orientation to be obtained from this book is essential if they are to appreciate the modern approach to problems of man's welfare in the face of environmental stress. For reasons which are set out in one of the later papers (A. P. Gagge, *Amer. J. Physiol.*, 131: 93–103. 1940), variations in atmospheric humidity are given a subordinate place in the authors' considerations, but this detracts somewhat from the direct application of their work to hot humid conditions, where vapor pressure must enter largely into practical considerations. The fourth chapter extends the concepts developed in the earlier ones to the design and use of clothing, and the next two chapters do the same for air conditioning. Those faced with tropical problems could wish that as much emphasis had been placed upon hot as upon cold conditions, but the weighting is a natural one. The attention given to the design of tropical headgear is perhaps excessive, since the heat absorbed from solar radiation is conveyed from the skin before it can penetrate the skull and adds only fractionally to the total heat load of the body. The last chapter discusses the relationships between climate, season, and health. To the reviewer this smacks too much of certain popular generalizations, and stakes too much upon the assumption that the coexistence of a life process or state with certain geographical conditions is proof of a causal relationship. Its inclusion tends to weaken the scientific merit of the book, and to cloud the objective scientific interest which inspired the Pierce Laboratory investigations. Nevertheless, the book as a whole is well worth study, though with diligence and independent judgment.

DOUGLAS H. K. LEE

MAN IN THE PRIMITIVE WORLD. *An Introduction to Anthropology. McGraw-Hill Series in Sociology and Anthropology.*

By E. Adamson Hoebel. McGraw-Hill Book Company, New York, Toronto and London. $5.00. xii + 543 pp.; ill. 1949.

This new textbook of anthropology is about midway between the short, factual, practical book for the undergraduate and the lengthy, sophisticated, theoretical treatise that might be admirable or not, depending on the quality of its theories, but is in any case somewhat beyond the needs of the undergraduate. It is an intelligent, competent treatise, best in its chapters on social relations like marriage, property, law, and government. It also gives attention to fields like housing and art, often neglected in textbooks. The latter chapters profit particularly from the excellent illustrations.

ERWIN H. ACKERKNECHT

GENERAL ANTHROPOLOGY.

By Harry Holbert Turney-High. Thomas Y. Crowell Company, New York. $4.00. xx + 581 pp.; ill. 1949.

Among the many recent attempts to bring out a useful textbook in anthropology for undergraduates, this seems to be the most practical we have seen so far. While it might lack the more or less brilliant formulations and subjectivities of other enterprises, the author still adheres to the almost forgotten, but well-tried rule "that the undergraduate should be grounded in descrip-

tive facts before being launched into theory." Thus he describes competently the basic data on physical anthropology, archeology, ethnography, and ethnology. Numerous well chosen illustrations enhance the pedagogic value of this text, which is also praiseworthy for its manageable proportions.

ERWIN H. ACKERNECHT

THE THEORY OF HUMAN CULTURE.

By James Feibleman. Duell, Sloan and Pearce, New York. $5.00. xiv + 361 pp. 1946.

This is a metaphysical speculation on the nature of human culture, and is based on the hypothesis that culture is the result of the response made by members of a social group to a hierarchy of three fundamental human drives—feeding, breeding, and inquiry. In this, at least, Feibleman avoids the single motive explanation so popular with some of his contemporaries, particularly those who are disciples of Freud (sex), Marx (economic), or Nietsche (will-to-power). Also he is, shall we say, more conservative than Ratzenhofer, who postulates five basic motives.

The author divides his subject in three parts. The first part, on the Elements of Culture, deals with The Human Individual, The Theory of Common Sense, The Theory of the Ethos, The Organization of Culture, The New Ethnology, Types of Culture, and The Movement of Culture. Part II deals with some examples of culture, such as the Maya, Pueblo, and Baiga, as representatives of early cultures, and with those of the Chinese and English, as examples of advanced cultures. In Part III of the book some consideration is given to the Treatment of Culture, its advancement both from a social and individual point of view, and to the possible question of a science of culture.

With the exception of Part II of the book, this reviewer found it rather heavy going, and suggests that those readers who may be interested in the book try this sample before plunging in:

"The psychological order whereby psychic events follow one another in time is a compromise between the logical order of being or possibility and the historical order of existence or actuality. The psychological order endeavors to apprehend the logical order in the historical, to bring to earth by means of feeling, reasoning and acting the logical possibilities of ontological values which have not yet been made available to experience. Students of philosophy, psychology and biology are fond of pointing to the faculty of reasoning and the cognition of universals as the distinguishing characteristic or ability marking off the human being from the higher animals. Feeling they condemn as a faculty shared by human beings with the higher animals, but this is an error made in consequence of dividing reasoning too sharply from feeling. There is another error involved, and this consists in assuming that while reasoning cognizes universals, feeling is only affected by the concrete, on the further assumption that not only are reasoning and feeding divided but also universals and values. Through the cognition of universals, the feelings are led to apprehend abstract values" (p. 22).

DAVID B. TYLER

THE COMMUNITY OF ERAI (WETAR). (*Texts and Notes*). *Studies in Indonesian Culture, II. Verhandelingen Der Koninklijke Nederlandsche Akademie Van Wetenschappen, Afd. Letterkunde. Nieuwe Reeks Deel L, Number 2.*

By J. P. B. De Josselin De Jong. N. V. Noord-Holandsche Uitgevers Maatschappij, Amsterdam. f. 7.50 (paper). iv + 152 pp. + 1 plate; text ill. 1947.

Erai is a hamlet on Wetar, an island north of Timur. J. P. B. D. deJong spent 18 days in Erai. Most of his book consists of 25 texts, mostly myths, collected during this time, together with their translations, grammar, and vocabulary. In a 32-page Introduction the author reconstructs from the hints given in the texts the nature of the family system, ritual, warfare, and material culture of Erai, combining with it what little observational material he had collected. This is a useful but not very impressive monograph.

ERWIN H. ACKERKNECHT

THE BANTU TRIBES OF SOUTH AFRICA: *Reproductions of Photographic Studies. Volume III, Section II, The Nguni: Section II, The Mpondo and Mpondomise. With an Introductory Article on the Mpondo and Mpondomise, and Descriptive Notes on the Plates.*

By A. M. Duggan-Cronin; introductory article and notes by Monica Wilson. Deighton, Bell & Company, Cambridge, England; Alexander McGregor Memorial Museum, Kimberley. 25s. (paper). 19 pp. + 40 plates. 1949.

This is another volume of the photographic anthology of the South African Bantus. As in previous volumes: 1) the pictures are posed too often for this reviewer's taste; 2) an excellent introduction is provided by a first-rate anthropologist who possesses an intimate knowledge of the tribe, in this case Mrs. Monica Hunter Wilson.

The 330,000 Mpondo and the less numerous Mpondomise show all the familiar Bantu traits: family kraals, the cattle complex, ancestor worship, etc. An interesting variation is that, unlike the aggressive Zulu and Swazi, they organized their defensive regiments not on an age group but on a territorial basis. Modern conditions, keeping 50 per cent of the able bodied men away in the mines, soil erosion, etc., have produced serious disruptions of tribal life.

ERWIN H. ACKERKNECHT

THE NEGRO IN THE UNITED STATES.

By E. Franklin Frazier. The Macmillan Company, New York. $6.00. xxxii + 767 pp.; ill. 1949.

The well-known sociologist to whom we owe already so many excellent detailed studies of the Negro problem gives here a synthesis of his own and the total body of existing research on it. He describes the development of the Negro community and its institutions, and the emergence of the Negro as a racial minority. A first part of the volume is devoted to the social and economic status of the Negro under slavery. The second part deals with "emancipation," following the disenfranchisement of the Negro and the restoration of "white supremacy" in the South. A third part contains an extensive demographic and sociological analysis of all types of present-day Negro communities, their classes, the Negro family, churches, fraternal organizations, and business. Education on all levels, the Negro press, intelligentsia, and social movements are reviewed in part four. The fifth part discusses problems of adjustment like health, family disorganization, crime, and race prejudice. Frazier emphasizes the tremendous change in the status of the Negro during the last thirty years, brought about through urbanization and the great migrations of the two World Wars.

One is struck by the comprehensiveness and scientific value of the study under consideration as well as by the extreme wealth of detailed studies of high quality upon which it could be based. They too might be not merely a reflection, but a real factor in the change of the last 30 years. The only major omission is an analysis of the experiences in the armed forces in World Wars I and II. Sometimes parallel figures for the white population (as in the case of the occupational "pyramids" on pp. 293, 295, 297) would have been desirable. As a whole this is a most valuable book.

ERWIN H. ACKERKNECHT

THE AMERICAN WOMAN IN MODERN MARRIAGE.

By Sonya Ruth Das. Philosophical Library, New York. $3.75. iv + 185 pp. 1948.

According to the author, the emancipation of woman has advanced farther in the United States than anywhere else, thanks to voluntary motherhood, economic independence, intellectual progress, political freedom, and the feminist movement; and hence American women have acquired a "new individuality." Marriage has become a functional and dynamic relationship, and the family has become a democratic organization. This has brought about a few problems like the necessity of a new code of feminine ethics, and the adjustment of the conflicting interests of modern woman as individual, mother, and wife.

The little book is the adaptation of a French Ph.D. thesis of 1934, and as dull as it should be. It gives a few useful data, but less than one would expect in view of the detailed work done by others in the field. The author is a feminist, and thus feels, in spite of reporting our appalling divorce rate (31 per cent in 1945), that everything over here is just fine.

ERWIN H. ACKERKNECHT

VOLUNTARY PARENTHOOD.

By John Rock and David Loth. Random House, New York. $3.00. viii + 308 pp. 1949.

According to the publishers' blurb, this is a "self-help book in the sense that it is meant to help the reader plan his or her own family." Basically it is a sound piece of work, as one would expect from the distinguished authors. As a guide for layman, however, it seems open to criticism on several counts:

1. It is written in a rather verbose style and contains much material which seems not to be relevant to the subject. Included are a number of "case histories" about Harry and Harriet, or the B——'s, etc. This is an effective educational device if used sparingly, but it will irritate some readers if used to excess.
2. The technical detail offered in certain chapters, especially those on the causes and treatment of infertility, is far too great for the layman's need and understanding. On the other hand, one wonders whether it would not have been possible to list the jellies, creams, and suppositories tested and approved by the American Medical Association, especially since other contraceptive procedures are described with complete directions for use.
3. There are no bibliographic references whatsoever, neither as documentation for specific statements (including many quoted directly), nor as suggestions for further reading.
4. The Catholic point of view is represented fairly in the words of the Rev. Francis J. Connell of the Catholic University of America. However, the implications of this point of view are only hinted at, and are not discussed.

In addition, the book has its share of factual errors, misinterpreted statistics, and other blemishes. These probably will not do the lay reader much harm, but they could easily have been avoided.

CHRISTOPHER TIETZE

LENGTH OF LIFE. *A Study of the Life Table. Second Edition.*

By Louis I. Dublin, Alfred J. Lotka and Mortimer Spiegelman. The Ronald Press Company, New York. $7.00. xxvi + 379 pp.; ill. 1949.

This is the second edition, much enlarged and thoroughly brought up to date, of the two senior authors' classical text on the life table, originally published in 1935. The first edition has long been out of print,

and the new one will fill a definite need. Very skillfully the book combines offerings at different levels of complexity. For the educated layman it has a lucid presentation of the elementary principles of the life table and a chronicle of progress in the field of health and the prolongation of human life from the dawn of history to the present day. Social scientists and medical men will be able to obtain much useful information on the relationships between death rates and such factors as sex, age, marital status, race, occupation, heredity, and specific diseases. Demographers and public health workers will notice the new chapter on forecasts of mortality and longevity and the discussions on estimates of future population and on "generation" or "cohort" life tables. The detailed exposition of an abridged method of life table construction will be particularly useful to them. The connoisseurs will certainly enjoy the magnificent collection of almost one thousand life tables (e_x and q_x values) presented as an appendix to the volume.

CHRISTOPHER TIETZE

OLD PEOPLE. *Report of a Survey Committee on the Problems of Ageing and the Care of Old People. Under the chairmanship of B. Seebohm Rowntree. The Nuffield Foundation, Geoffrey Cumberlege, Oxford University Press, London and New York.* $1.50 (paper). viii + 202 pp. + 14 plates. 1947.

One of the objects of the Nuffield Foundation is the "care and comfort of the aged poor." To aid in implementing this object, a Survey Committee was appointed to look into the problems of ageing and the aged, and to consider what has been done and what might be done to alleviate them. The Committee's report, *Old People*, deals with the social status of the aged and with the measures being taken to improve it. That the information was obtained through leisurely interviews made by skilled field workers is reflected in the specific and detailed nature of the report. Almost half the book is given over to appendices presenting data relating to the questions raised by the text itself.

The first chapter of findings, dealing with the incomes of the old, reviews the development of public assistance and pension schemes in Great Britain. Under the National Insurance Act passed in 1946, 42s. weekly will be paid to a retired couple when the husband is past 65. Since this, as the report shows, is barely subsistence at present price levels, it is interesting that the sum, though diminished if the pensioner continues to earn, is increased when retirement does occur. The chapter on unemployment reveals that in 1945 a large majority of men between 65 and 75 were employed, except in the mining districts. According to employers, there are only a few industries in which places cannot be found that the elderly can fill as well as—and often better than—younger workers. The employment situation indeed seems better than the recreational situation, although one large club organization is described which has done much to relieve the boredom from which old men suffer.

The most depressing chapters are those that deal with housing conditions. Most of the elderly were found to be living under deplorable conditions, frequently without toilets or water. (But the evidence did indicate that the homes of the aged are not worse than those of younger members of the same classes.) Homes and institutions proved to be quite variable; but the number of well-staffed, well-run institutions was found to fall far short of the demand. Numerous specific recommendations are made for improving the housing and care of old people.

One gathers that the situation of the dependent aged is neither substantially better nor worse in Britain than in the United States. Hence the Nuffield Report should prove to be a valuable sourcebook to those in this country who want information on the various social facets of the steadily widening problem of old age.

FLORENCE MOOG

FORECASTS OF THE POPULATION OF THE UNITED STATES 1945–1975.

By P. K. Whelpton; assisted by Hope Tisdale Eldridge and Jacob S. Siegel; prepared under the supervision of Leon E. Truesdell. United States Department of Commerce, Bureau of the Census, Washington, D. C. 45 cents (paper). vi + 113 pp.; ill. 1947.

This is the fourth set of population projections or forecasts for the United States prepared by the staff of the Scripps Foundation, the first set having been published in 1934. The computations underlying the present edition were for the most part completed in the fall of 1945, a particularly unfortunate time for an undertaking of this nature. In the first place, the spectacular postwar "baby boom" was still in the future, and as a result even the projection based on the assumptions of "extra high" fertility, low mortality, and 200,000 immigrants per year (Table VII) has been far surpassed by the actual course of events. More important, much of the criticism leveled in recent years against the conventional net reproduction rate and population projections based on such rates had not yet been made, and none of the later improvements in technique (including certain very important contributions by Whelpton himself) were available. There can be no doubt that a fifth set of projections, if and when it is prepared, will be very different from its predecessors, although perhaps more in methodology than in the numerical results.

The analyses of the causes of the long-term decrease in fertility, of the short-term changes in birth rates, and of the implications of the expected trends in population growth and composition are most lucid and

reasonable, and should be carefully read and studied by everyone interested in the demography of the United States.

CHRISTOPHER TIETZE

1948 YEARBOOK OF FOOD AND AGRICULTURAL STATISTICS. *Including Notes in Spanish. Volume I. Production.*

Food and Agriculture Organization of the United States, Washington, D. C. $3.50 (paper). xviii + 285 pp. 1949.

This is a second volume of a series issued by FAO. Like the 1947 volume, it continues the statistical series on crops and numbers of livestock formerly published by the International Institute of Agriculture at Rome. Tables are presented showing area and production figures for the principal crops in the prewar period (generally 1934–38 averages) and in 1945, 1946, and 1947. The livestock numbers given are for the latest prewar year. This edition of the *Yearbook* also carries on the work of the International Institute of Agriculture by giving a series of tables showing in detail, for specified countries, the utilization of land for crops and the output therefrom, together with detailed classifications of livestock numbers by sex and age groups, wherever these are available. New to this issue of the *Yearbook* is the introduction of tables containing information on total population by countries and on the number of persons engaged in agricultural occupations. Tables have also been added on the production of condensed, evaporated, and dried milk. As a general rule, figures included in the tables of this *Yearbook* have been supplied by governments through special questionnaires, or have been taken from official government publications. It is likely that more recent and more objective information regarding special agricultural commodities can be obtained from the office of Foreign Agricultural Relations of the United States Department of Agriculture. This office has its own sources of information, and it is believed that its figures are more nearly correct and up to date than those contained in such a publication as this, compiled from official sources.

ROBERT L. PENDLETON

FREEDOM FROM WANT: *A Survey of the Possibilities of Meeting the World's Food Needs. A Symposium. Chronica Botanica, Volume 11, Number 4.*

Edited by E. E. DeTurk, with a foreword by Norris E. Dodd. Chronica Botanica Company, Waltham, Mass.; Stechert-Hafner, New York. $2.00 (paper). Pp. 207–283; ill. 1948.

In an introduction, Norris E. Dodd views the future with hope. "After all," he says, "human understanding is itself a biological phenomenon and if it is given a chance to develop it is bound to make a difference in the way people act." To the reviewer, notwithstanding these words, Salter seems over-optimistic in his estimates of the productive capacity of tropical regions which are as yet not producing any considerable quantity of food crops. He has made the mistake of judging the potential productive capacity of the soils of the tropics on the basis of crop production in the Philippines; but those Islands have much better than average tropical soils. Black emphasizes that freedom from want is only relative, and "relative" is a very broad term. He shows that as undeveloped communities and nations modernize their economies, the rate of population growth can be brought within more reasonable limits. Tolley contends that such results can be achieved with knowledge and effort of both the physical and the social scientists if pooled in a concerted world-wide effort. Quisenberry, in telling of what has been accomplished by increasing crop production in the more advanced countries, suggests the future possibilities in other parts of the world. Morrison compares the relative efficiency of various farm animals as food for humans and some other considerations bearing on increased production. McCall emphasizes the need for better, quicker ways of getting scientific knowledge about improved land use into widespread use on farms. It should be noted that these papers were presented in 1946; and that FAO has an implied if not often stated date of 1960 for the time when world food supplies can be expected to catch up with the population. FAO seems to be silent about the more distant future.

ROBERT L. PENDLETON

BIOMETRY

PROBABILITY THEORY FOR STATISTICAL METHODS. *By F. N. David. Cambridge University Press, London.* $3.50. x + 230 pp. 1949.

In this treatise the author states and proves in mathematical language those propositions and theorems of the calculus of probability which should be useful for students of mathematical statistics. The professional statistician or biometrician will find this an interesting work mainly because of its basic treatment of such topics as the evaluation of binomial probabilities by the incomplete B-function ratio, Laplace's theorem, the Poisson distribution, Bayes' theorem, the Markoff theorem, and so on. The book is much too technical and mathematical for most students in the biological sciences, who are interested in statistics only as a tool. It should, however, be useful as collateral reading for the occasional, rare student who comes to his first course in statistics with an excellent background in calculus.

A. CHAPANIS

STATISTICAL METHODS IN RESEARCH.

By Palmer O. Johnson. Prentice-Hall, New York. $5.00. xviii + 377 pp.; ill. 1949.

This book, in the reviewer's opinion, is one of the best, and very nearly one of the most complete, textbooks on statistical methods available to students of the biological and behavioral sciences. Especially noteworthy is its excellent and thorough treatment of the analysis of variance, covariance, and the small sampling techniques. Most of the problems and illustrative materials are taken from the psychological literature. It is refreshing to find at last a textbook in this area which does not use agricultural experiments as examples.

There is a chapter on the statistical analysis of data under non-normal assumptions and a good section on the use of transformations—two important topics which are treated lightly or not at all in many textbooks. The two chapters on the design of experiments are considerably more comprehensible than similar discussions by British statisticians. American students have long needed a reasonably understandable discussion of this highly important topic. There are, on the other hand, some rather conspicuous omissions in the book. Chi-square is given only a cursory treatment; and curve-fitting, a technique of great usefulness to the experimentalist, is not even mentioned.

This is an advanced textbook. The author assumes that the student has already had a course in descriptive statistics, and he recommends "at least a background in calculus." Even so, the text is considerably more difficult than it ought to be. It is hard to escape the feeling that when the author could have said something in either of two ways, he invariably chose the more involved and difficult one. Nonetheless, it is a comprehensive book, and it should be extremely valuable for those students who "can take it."

A. CHAPANIS

STATISTICAL TABLES FOR BIOLOGICAL, AGRICULTURAL AND MEDICAL RESEARCH. *Third Edition Revised and Enlarged.*

By Ronald A. Fisher and Frank Yates. Oliver and Boyd, Edinburgh. 16s. viii + 112 pp. 1949.

The Fisher-Yates *Statistical Tables* need no introduction to statisticians and biometricians. The third edition of these highly useful tables has been improved mainly by a number of additions to and extensions of the tables in the second edition. Thus, 10 per cent points of z and e^{2z} have been added, orthogonal polynomials are now available for values of n′ from 53 to 75, and the table of natural logarithms has been extended. Five other tables have been revised to increase their usefulness. One new table, giving the modified probit weighting coefficients necessary for dosage mortality tests involving deaths among controls, has been added.

A. CHAPANIS

DE OMNIBUS REBUS ET QUIBUSDAM ALIIS

THE ROYAL SOCIETY EMPIRE SCIENTIFIC CONFERENCE, JUNE–JULY 1946. *Volumes I and II.*

The Royal Society, London. £2 2s. 0d. (I) 828 pp. + 1 plate + 4 maps + 8 charts; text ill. (II) 707 pp. + 1 map; text ill. 1948.

This conference was held in London, Cambridge, and Oxford. Many of the leading scientists of the Empire presented papers which epitomized the work and progress in their respective fields in Great Britain or in their dominion or colony. Since space forbids even giving the titles of these papers, the subjects covered can best be indicated by the topics of the morning discussions: (a) a survey of some outstanding problems in agricultural science in the Empire; (b) a survey of some outstanding problems in medical science; (b-1) discussion of the physiological and psychological factors affecting human life and work under tropical conditions and in industry, (b-2) the etiology and control of infectious and transmissible diseases, particularly those which are insect-borne; (c) the present state of the science of nutrition with particular reference to the special problems of the Empire, including the nutritional status of the indigenous peoples of the Colonies; (d) modern methods of mapping and exploration by air, including the use of radio technique in ordnance survey, with special reference to particular parts of the Empire; (e) measures for improving scientific information services within the Empire, the subjects discussed including indexing, abstracting, special libraries, and microfilms; (f) methods of improving the interchange of scientists throughout the Empire, including a discussion on the future of the scientific liaison offices that have been established during the war; (g) Empire cooperation in the scientific field with existing and projected international organizations; (h) measures which might be taken to secure greater uniformity in physical standards of measurement and the use of units, terms, and symbols; (i) the collection and interchange of scientific records and experimental material, including the safeguards that will have to be taken to minimize the risk involved in the distribution of plants, seeds, and animals; (j) the problems of land utilization and conservation throughout the Empire, bringing together the various factors affecting land utilization and conservation including forestry, soil erosion, irrigation, etc.; (k) the need for a coordinated survey of the mineral resources of the Empire and for operations on a much larger scale than hitherto; (l) the natural products of the Empire and the chemical industries that are or might be based on them; (m) post-war needs of fundamental research; (n) an all-African organization for the coordination of scientific work within the African Continent. Fortunately these volumes have relatively detailed indices which make it possible to discover and to refer to much of the enormous range of information contained in them.

ROBERT L. PENDLETON

STUDENT'S HANDBOOK OF SCIENCE.

By Bernard Udane and Herman W. Gillary. Frederick Ungar Publishing Company, New York. 75 cents; 60 cents per copy for ten or more (paper). 208 pp.; ill. 1948.

This book has been prepared by two science teachers in the Forest Hills High School in New York City to meet the need for guidance of science students. Paul Brandwein, Chairman of the Science Department in this school, says in the Foreword: "This little book should be in the hands of every science student—not because all science students are to be scientists but because all of them need to know whether they are fitted for a science career, whether they are getting the most out of their work in science, whether they can improve their study habits, and how science can contribute to their enjoyment of living." Not only will this book be of great service to the science student, it should also be an invaluable aid to the busy teacher because it will offer guidance which would require hours upon hours of the teacher's time to render to each individual student. Furthermore, this guidance will be from experts who have placed more winners in the annual Westinghouse Science Talent Search than any other single group of teachers in the nation.

The book is divided into four parts: I) How You Can Prepare for a Career in Science; II) How You Can Get a Good Start in Your Science Career; III) How You Can Be a Better Science Student; IV) How You Can Develop Your Science Interests at Home.

Part I lists 100 vocations related to science and 56 publishers of pamphlets on these vocations. Aptitude tests and scholarships are also discussed in detail. Parts II and III show the student how to plan his program in detail, how to make drawings and take notes, how to make a science report, how to carry on many extracurricular science activities, how to keep a good notebook, how to use the library, how to keep abreast of science news with current science magazines, etc. Part IV will help any interested students to develop a science hobby even though they may not be planning to enter upon a science career. Hobbies discussed include: nature study, bird watching, entomology, plant studies, microscopy, photography, astronomy, geology, meteorology, radio, and several more. This Part concludes with chapters on purchasing science supplies and building a science library. The Appendix gives information on culturing and caring for laboratory organisms, on taxonomy, a table of elements, common formulas, temperature scales, equations, and other useful material. Busy teachers and interested students owe a real debt to these authors for making available at last a useful and well organized book of this kind.

ELLA THEA SMITH

PRÉCIS DE MICROSCOPIE: *Technique, Expérimentation, Diagnostic. Seventh Edition.*

By M. Langeron. Masson et Cie., Paris. 2600 fr. viii + 1430 pp.; ill. 1949.

There is no single equivalent written in the English language to M. Langeron's standard French work on all aspects of biological laboratory technique which involve the use of the microscope. The book consists in reality of three sections which are largely independent. The first of these (353 pages) deals with the optical and mechanical principles of the microscope, with chapters on special topics such as dark-ground illumination, phase-contact and ultra violet microscopy, micromanipulation, photomicrography, camera-lucidas, etc. This part of the book, with certain reservations to be noted later, is very well done, the theoretical sections on the optical principles of the various methods being interspersed with practical hints, written from the standpoint of a laboratory scientist who really knows how to get the most out of the equipment he uses. Naturally, the instruments described and figured are almost exclusively those provided by European manufacturers, the microscopes of Zeiss and Stiassnie (Paris) being conspicuous. This does not detract in any way from the value of the theoretical discussion to American readers, but a good many of the practical hints are hardly applicable to the equipment used in American laboratories. The sections on phase-contrast and electron-microscopy are somewhat weaker than the rest of this section of the book, being written from the standpoint of pure theory rather than from that of practical experience. Even here, however, the theoretical discussions are admirably clear and easy to follow. The chapter on micromanipulators is devoted largely to a description of the instrument of de Fonbrune, a very superior type of microdissection apparatus developed recently in France, and one which should be more widely known and used in this country. In contrast to this, the chapter on photomicrography is a complete disappointment, since the author appears to suffer from the curious delusion that the only way to get good photomicrographs is to use a "Universal Microprojector" invented by a certain Dr. Leroux (there is no mention of the many types of excellent photomicrographic cameras manufactured in this country and in pre-war Germany).

The second section of the book (400 pages) deals with histological technique. In a general way this corresponds to the well-known "Microtomist's Vade-Mecum," but the principles underlying the methods are much more fully explained. The chapters dealing with section-cutting are as concise and clear as those in the first part of the book, and the techniques recommended for fixation and staining are not so very different from those in general use in this country.

The third part of the book is entitled Special Methods. It deals with techniques suitable for the micro-

scopical study of all types of organisms from amebas and bacteria to the higher animals and plants—there is even a paragraph on special histological methods for studying the tissues of mummies. This part of the book is especially aimed at the medical reader, particular attention being devoted to methods used in parasitology, hematology, and even in medico-legal practice. The section on entomological techniques deals in considerable detail with the insects which are important in medical entomology, methods for rearing mosquitoes, lice, and fleas being fully explained. Histochemical reactions receive a very adequate treatment. Cytological techniques used for the study of the cytoplasm are fully described, but the section on chromosome cytology is completely inadequate and so brief as to be almost unintelligible.

In many respects "Langeron" has an antique flavor, coming from a country where many modern aids to scientific work are unknown or unobtainable. To members of the French medical profession (especially those working in the isolation of the French colonies) it must be an invaluable work. To those of us fortunate enough to be working in well-equipped American laboratories (and who necessarily rely largely on handbooks and instruction manuals supplied by the makers of the instruments we use) it will be less useful. But almost every working biologist could find much valuable and pertinent technical information in this most comprehensive work.

M. J. D. WHITE

THE ORIGIN OF MEDICAL TERMS.

By Henry Alan Skinner. The Williams & Wilkins Company, Baltimore. $7.00. viii + 379 pp. 1949.

Quite a number of books try to bridge the gap between the continuous necessity of using a special terminology and the ever increasing illiteracy of our students. There are the big medical dictionaries with innumerable short references to all possible terms. There are also the more detailed books on anatomical nomenclature, which does seem to be more of a problem to the student than the rest of medical terminology, primarily because he clashes with it first. Skinner's dictionary is superior to many other attempts in the same direction because it includes all medical terms, and not only the anatomical ones. Furthermore, it tries to explain not every term or name, but restricts itself to the essential ones, giving them in exchange a more thorough treatment. The book is factually sound, well selected, and well written. The occasional inclusion of such proper names as were not used for eponyms or whose owners were not of decisive importance in the history of medicine (like Alhazen, Amuzat, Balard, Bellini, Berengarius, etc.) seems superfluous. The student can look up such names in current medical history reference books, like those by Garrison or Mettler. Medical students and doctors will consult this volume with profit as well as pleasure.

ERWIN H. ACKERKNECHT

BLAKISTON'S NEW GOULD MEDICAL DICTIONARY. *A Modern Comprehensive Dictionary of the Terms Used in All Branches of Medicine and Allied Sciences, Including Medical Physics and Chemistry, Dentistry, Pharmacy, Nursing, Veterinary Medicine, Zoology and Botany, as Well as Medicolegal Terms.*

Edited by Harold Wellington Jones, Normand L. Hoerr and Arthur Osol; with the cooperation of an Editorial Board and Eighty Contributors. The Blakiston Company, Philadelphia and Toronto. $8.50. xxviii + 1294 pp. + 45 plates. 1949.

STEDMAN'S MEDICAL DICTIONARY *of Words Used in Medicine With Their Derivations and Pronunciation Including Dental, Veterinary, Chemical, Botanical, Electrical, Life Insurance and Other Special Terms; Anatomical Tables of Titles in General Use, the Terms Sanctioned by the Basle Anatomical Convention; the New British Anatomical Nomenclature; Pharmaceutical Preparations Official in the U. S. and British Pharmacopoeias or Contained in the National Formulary; and Comprehensive Lists of Synonyms; Biographical Sketches of the Principal Figures in the History of Medicine. Seventeenth Revised Edition With Etymologic and Orthographic Rules.*

Edited by Norman Burke Taylor; in collaboration with Allen Ellsworth Taylor. The Williams & Wilkins Company, Baltimore. $8.50 (with thumb index); $8.00 (without thumb index). xliv + 1361 pp. + 6 plates; text ill. 1949.

Advances in every branch of medicine and the basic sciences related to it have enlarged the terminology whereby these advances are described. New words and new meanings for old words have never been coined so abundantly as in recent years. New, up-to-date dictionaries are essential for anyone who would be accurately informed concerning things medical. These two dictionaries are intended to fulfill this purpose.

The *New Gould Medical Dictionary*, although stated to be a first edition, is the successor of the original Gould published in 1890 and followed by nine new editions, including this one, four of them labeled "first." Eighty contributors aided the three chief editors. Special tables of arteries, enzymes, vitamins, and monstrosities are included. An atlas of 252 illustrations, 129 in color, deals mainly with anatomical, blood, bacterial, and parasitological subjects. An appendix of 135 pages includes tables dealing with data anatomic, blood, dietary, enzymic, hormonal, vitamin, therapeutic materia medica, etc. An earnest effort to follow the best etymological practices is claimed by the editors. They have, they say, "diligently searched

recent professional literature not only for new terms but also for evidence of the changes in usage which they felt were evident today. . . . More than three hundred standard modern texts reflecting current usage and nomenclature in all the basic fields of medicine, surgery and the biologic sciences as well as recognized journals, yearbooks and standard indexes of many specialties were critically and systematically examined." Biographical sketches of contributors to medical science and literature are given throughout the text.

In the new *Stedman's Medical Dictionary*, the editors have endeavored to delete "dead wood," revise outmoded definitions, and add new ones. Trade names have been deleted. In this edition, short biographical notes on the principal figures in the history of medicine are included in appropriate definitions of diseases, procedures, or discoveries. An appendix deals mainly with a comparative list of anatomical terms (Latin, B.N.A., and Anatomical Society of Great Britain), weights, measures, temperature scales, etc. Line cuts, half-tone, and color inserts are found generously throughout the text.

In evaluating a dictionary, a reviewer must do so in the field of his own particular competence. With this limitation, a careful comparison of these two volumes had been made with respect to the physiology of reproduction and gynecic physiology. It was reassuring to find an exceedingly high degree of accuracy in the new Stedman's. This was not true, repeatedly, in the case of the New Gould. A few examples will suffice to illustrate the point. *Alphaestradiol* is defined simply as *estradiol*. Under *estradiol, alphaestradiol* is correctly listed as "the active isomer of estradiol." The three indicated pronunciations for *estradiol* will leave the uninitiated at a loss as to which is common or preferred. *Progestin* is incorrectly stated to be a trademark name for a brand of *progesterone*. The name *progestin* was agreed upon by a Committee of the League of Nations to be reserved for all tissue extracts having demonstrable progestational activity. The value and wisdom of including *progestone* and *progestoral* as trademarked names of proprietary preparations is questionable. *Progestational* is stated quite incorrectly to be obsolete; *progravid*, it is said, is now preferred. These are but a few of numerous similar points that were noted in perusing this dictionary for one evening.

With respect to biographical references, both dictionaries leave something to be desired. In the first place, a definite policy should be adhered to with respect to the inclusion of biographies. Thus, the New Gould gives a sketch of Visscher of the Visscher-Bowman pregnancy test (a test little used nowadays), but not of Bowman. No sketch is given of Friedman, although this test is still one of the most widely used tests for pregnancy. Lapham, of the Friedman-Lapham test, is not mentioned. Again, sketches of Ascheim and Zondek are given, but none of Smith and Engle, whose discoveries with respect to gonadotrophic hormones are no less important than, and were concurrent with those of the former investigators. In Stedman's, two mistakes in the names of living individuals were found in the first six that were looked up. The merit of such references in either dictionary appears dubious, to say the least.

S. R. M. REYNOLDS

A MENCKEN CHRESTOMATHY.

Edited and annotated by H. L. Mencken. Alfred A. Knopf, New York. $5.00. xvi + 627 pp. 1949.

It is said that some Baltimore mothers used to threaten their misbehaving children, not with the usual bogeyman, but with "Mencken will get you if you don't be good!" I also have it, and on equally good authority, that such treatment, depending of course on the constitution and age of the infant, could interfere with its normal feeding process, thus leaving the child with a feeling of insecurity. This, in turn, could result in memory impressions that would ultimately make the unconscious a dynamic center of psychic energy rather than a bin of harmless impressions. This, as probably everyone knows, can produce an anxiety, and if repeated frequently enough, can establish at a very early age definite psychopathology. Some students of the subject, particularly those prone to premature conclusions, hold that such a series of events accounts for what they loosely describe as the "Baltimore Neurosis." To attribute this psychic manifestation, especially one of such a broad nature, as being solely due to the fact that some children were frightened by the threat of Mencken is, I think, an oversimplification of the problem. I know of a case where an older son was required to mind his younger brother during their parents' absence. Oftentimes he put him to sleep by reading aloud Mencken's *In Defense of Women*. The fact that the young one turned out to be a clinical endocrinologist specializing in male sterility would only be offered as supporting evidence for the above hypothesis by those so biased that they regard clinicians in any form as individuals with warped or hysterical personalities. I view with alarm such facile generalizations, on the ground that it gets us nowhere.

A second consideration bearing on the general question of H. L. Mencken and his ideas is his education, or rather lack of one. It is amazing to some that so many people accept as the absolute truth everything coming from Mencken, despite the fact that the man has no Ph.D., no M.A., not even an A.B. degree. A deficiency of this magnitude certainly disqualifies him as an authority on questions secular, sacred, or scientific. Furthermore, and he openly boasts of it (p. 132), he never went to college! This lack of a university education shows up strikingly in his comments on a wave

of suicides that occurred among college students back in 1927. I quote:

"What I'd like to see, if it could be arranged, would be a wave of suicides among college presidents. I'd be delighted to supply the pistols, knives, ropes, poisons and other necessary tools. Going further, I'd be delighted to load the pistols, hone the knives, and tie the hangman's knots. A college student, leaping uninvited into the arms of God, pleases only himself. But a college president, doing the same thing, would give keen and permanent joy to great multitudes of persons. I drop the idea, and pass on." (p. 133).

I am quite sure that if Mr. Mencken had spent even one semester in college, he would never entertain such ideas. I am equally sure that even in his freshman year he would have realized that all, well, practically all, college presidents have been picked primarily for their scholarship, ability, and integrity. Furthermore, if he showed any capacity for observation, he would very quickly see that all, well, practically all, of the faculty hold college presidents in the highest regard, and they would probably not derive any keen and permanent pleasure from such mass suicides (though it may be of great interest to those academically concerned with the phenomena of mass physiological and psychological behavior patterns).

Another example of Mencken's faulty education is his suggestion to abolish all the sorrows of the world by the "... simple device of getting and keeping the whole human race gently stewed." (p. 389). This idea, pleasant though it may be, is fraught with many difficulties, principally of a technical nature. If Mencken had gone to college and taken courses designed for the education of the Scientific Generalist (see *Science* 109: 553. 1949), it is probable that he would have been capable of offering some concrete methods on how this condition could be brought about. His simple suggestion that this can be accomplished by impregnating the air with alcohol and, with no further ado, leaving all the technical details to be worked out by men "skilled in therapeutics, government and business efficiency" is typical of the ignorant, and reminds many of the professional promotors of societies that promise, on the morrow, cures for cancer, polio, and other chosen diseases. Furthermore, the suggestion of using grain alcohol shows a complete disregard for individual variations in taste and ignores the fact that there are large groups who prefer blended distillates from Scotland. This narrow, undemocratic, and antisocial attitude is said to be typical only of those individuals who did not go to college.

It is highly probable that a college education would improve Mencken. If going to college is not possible for him, attendance at a good junior college, or maybe even Yale, would help. Had he done this in his earlier years, he would have altered many of the ideas that he sets forth in his *Chrestomathy* (which, as practically every college graduate knows, means a collection of choice essays).

It is customary, when a reviewer is greatly pleased with a book, to recommend it highly for the consideration of readers. This must be deferred until it is determined whether such action in this case makes one liable under Maryland's anti-subversive laws.

DAVID B. TYLER